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NAS PENSACOLA
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FINAL RECORD OF DECISION SITE 40 NAS PENSACOLA FL
8/27/2004
ENSAFE/ALLEN AND HOSHALL

FINAL RECORD OF DECISION
OPERABLE UNIT 15
SITE 40 — BAYOU GRANDE
NAS PENSACOLA
PENSACOLA, FLORIDA

SOUTHNAVFACENGCOM
Contract Number: N62467-89-D-0318
CTO-083

Prepared for:

NAVFAC
Naval Facilities Engineering Command
SOUTHERN DIVISION

Comprehensive Long-Term
Environmental Action Navy (CLEAN)
Naval Air Station Pensacola
Pensacola, Florida

Prepared by:

ENSAFE

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962
www.ensafe.com

August 27, 2004

FINAL RECORD OF DECISION
OPERABLE UNIT 15
SITE 40 — BAYOU GRANDE
NAS PENSACOLA
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Prepared for:

Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina

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The Contractor, EnSafe Inc. hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0318 is complete, accurate, and complies with all requirements of the contract.

Date: August 27, 2004
Signature: _____
Name: Allison Harris
Title: Task Order Manager

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LIST OF ABBREVIATIONS

The following list contains many of the abbreviations, acronyms, and symbols used in this document. A glossary of technical terms is provided in Appendix A.

AWQC	Ambient Water Quality Criteria
ARAR	Applicable or Relevant and Appropriate Requirement
AZ	Assessment Zone
BEHP	bis(2-ethylhexyl)phthalate
BRA	Baseline Risk Assessment
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chemical of Concern
COE	define (See Section 6)
COPC	Constituents of Potential Concern
DoD	Department of Defense
E/A&H	EnSafe/Allen & Hoshall
ERA	Ecological Risk Assessment
FDEP	Florida Department of Environmental Protection
FFA	Federal Facilities Agreement
FS	feasibility study
g/day	grams per day
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
HRS	Hazard Ranking System
ILCR	Incremental Lifetime Excess Cancer Risk
IRP	Installation Restoration Program
MCL	maximum contaminant level
mg/kg	milligram per kilogram
msl	mean sea level
NAS	Naval Air Station
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OU	Operable Unit

List of Abbreviations (cont.)

PAH	Polynuclear Aromatic Hydrocarbon
PBS	Pensacola Bay System
PCB	Polychlorinated Biphenyl
PEL	Probable Effects Level
ppb	part per billion
ppm	part per million
PRAP	Proposed Remedial Action Plan
PRG	Preliminary Remediation Goal
QA	Quality Assurance
QC	Quality Control
RAB	Restoration Advisory Board
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SQAG	Sediment Quality Assessment Guideline
SSL	Sediment Screening Level
SSV	Sediment Screening Value
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
SWQC	Surface Water Quality Criteria
tPAH	total Polyaromatic Hydrocarbon
TAL	Target Analyte List
TCL	Target Compound List
TEL	Threshold Effect Level
TOC	Total Organic Carbon
TRC	Technical Review Committee
TTC	Trophic Transfer Coefficient
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOC	Volatile Organic Compound
µg/kg	micrograms per kilogram
µg/L	micrograms per liter

DECLARATION OF THE RECORD OF DECISION

Site Name and Location

Operable Unit 15
Site 40 — Bayou Grande
Naval Air Station Pensacola
Pensacola, Florida

Statement of Basis and Purpose

This decision document (Record of Decision) presents the selected remedial action for Operable Unit 15 (Site 40, Bayou Grande) at Naval Air Station Pensacola, Pensacola, Florida, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, 42 U.S.C. § 9601 *et seq.*, and to the extent practicable, the National Contingency Plan, 40 Code of Federal Regulations Part 300. This decision is based on the administrative record for Operable Unit 15 at the Naval Air Station Pensacola.

The U.S. Environmental Protection Agency and the Florida Department of Environmental Protection concur with the selected remedy.

Description of Selected Remedy

This action is the first and final action for the operable unit. The remedial investigation and human health and ecological risk assessment conducted for Operable Unit 15 support a no-action remedial alternative. The remedial investigation and risk assessment have addressed all media at the site, and no other actions will be considered for Operable Unit 15.

Statutory Determinations

No remedial action is necessary to ensure protection of human health and the environment, therefore none of the CERLCA §121 statutory determinations are needed. The selected remedy is cost-effective and complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action. This remedy does not result in hazardous substances remaining onsite above health-based levels; therefore, a 5-year review will not be required.

Captain J. M. Pruitt, Commanding Officer
NAS Pensacola

10-4-04
Date

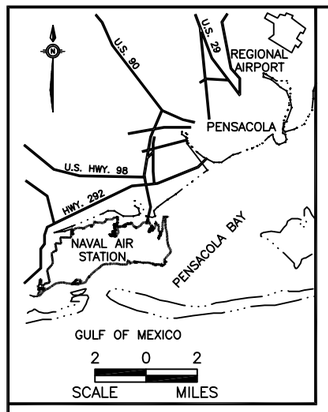
1.0 SITE NAME, LOCATION, AND DESCRIPTION

Operable Unit (OU) 15, including only Bayou Grande (Site 40), is an estuarine water body adjacent to the northern border of Naval Air Station (NAS) Pensacola in Escambia County, Florida (Figure 1-1). It has a total surface area of approximately 1.5 square miles (Olinger et al., 1975) and approximately 20 miles of total coastline. Approximately 8.5 miles of Bayou Grande coastline border NAS Pensacola property. Bayou Grande, with a mean depth of approximately 6 feet (Collard, 1991), is part of a larger surface water system known as the Pensacola Bay System (PBS).

NAS Pensacola land surface elevations range from 0 to approximately 40 feet above mean sea level (msl). The most prominent topographic feature at NAS Pensacola is a bluff paralleling the southern and eastern shorelines. Between the bluff and the shoreline is a nearly level marine terrace approximately 5 feet above msl. Gently rolling uplands reach elevations up to 40 feet above msl landward of the bluff.

Surface soil at NAS Pensacola consists primarily of highly permeable sands, which limit stream formation. Several naturally occurring intermittent streams and numerous man-made drainage ditches flow south into Pensacola Bay, which has a mean depth of 10 feet in the NAS Pensacola area.

The depth to groundwater at NAS Pensacola ranges from less than 1 foot to approximately 20 feet below land surface, depending on land surface elevation and proximity to surface water bodies, including Pensacola Bay. Groundwater is not currently used as a potable water source at NAS Pensacola, which receives its potable water from Corry Station, approximately four miles north.



LEGEND

- BUILDINGS & STRUCTURES
- NAS PENSACOLA BOUNDARY
- SHORE LINE
- STREAM
- MAIN STATION ENTRANCE

SCALE: NOT TO SCALE

NAVFAC Naval Facilities Engineering Command SOUTHERN DIVISION

SITE 40
ROD
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 1–1
SITE LOCATION MAP
PENSACOLA, FL.

DWG DATE:01/22/04 | DWG NAME:0083G004

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 General Site History

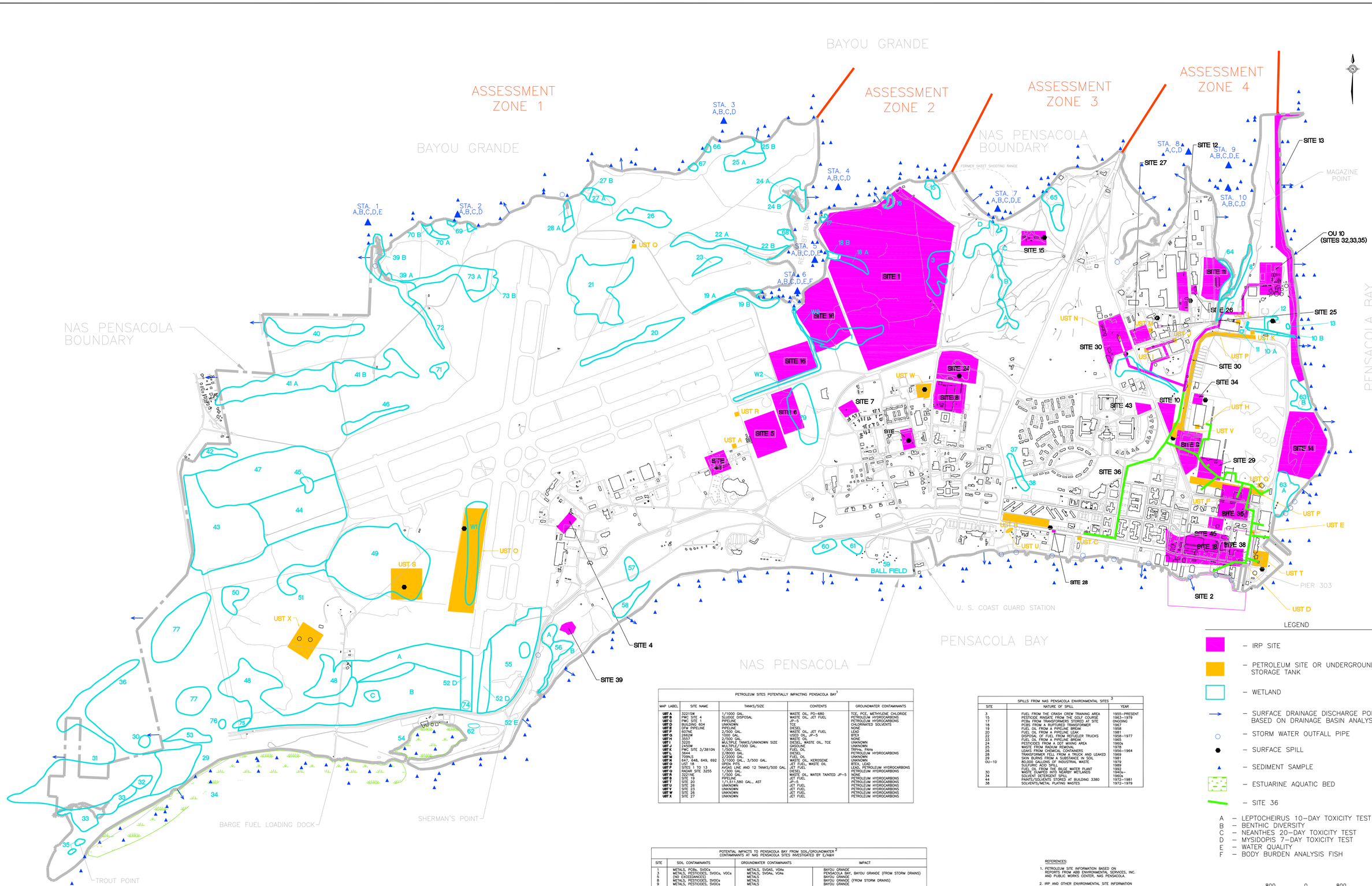
NAS Pensacola was placed on the U.S. Environmental Protection Agency's (USEPA) National Priorities List (NPL) in December 1989. The Federal Facilities Agreement (FFA), signed in October 1990, outlined the regulatory path to be followed at NAS Pensacola. NAS Pensacola must complete not only the regulatory obligations associated with its NPL listing, but also satisfy the ongoing requirements of a Resource Conservation and Recovery Act (RCRA) permit issued on the facility in 1988. That permit addresses the treatment, storage, and disposal of hazardous materials and waste as well as investigation and remediation of any releases of hazardous waste and/or constituents from solid waste management units (SWMUs). RCRA governs ongoing use of hazardous materials and the rules of the operating permit. RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) investigations and actions are integrated through the FFA, thereby streamlining the cleanup process.

2.2 Site-Specific History

Site 40 (0U 15), Bayou Grande, was included as a separate site for a remedial investigation based on the possible receipt of hazardous substances and that media within Site 40 may individually provide exposure pathways impacting human health and the environment (USEPA, 1989). The remedial investigation was completed from 1995 to 2000 and is summarized in the *Site 40 Remedial Investigation Report* (EnSafe, 2000) with *Remedial Investigation Report Addendum 1* (EnSafe, 2003) and *Remedial Investigation Report Addendum 2* (EnSafe, 2002).

Since the early 1950s, numerous investigations have been conducted in and around the PBS to monitor the ecological health of the bay and determine the impact of commercial, industrial, and municipal activities. Previous investigations have documented Navy industrial activities discharging to the PBS. Other studies have been associated with industrial activities of the PBS.

A preliminary survey and Phase I sediment mapping of Site 40 were conducted in February 1995 to identify potential sampling locations for further investigation. Sampling locations within Bayou Grande were selected based on a contaminant source diagram developed to evaluate sources of contaminant input to Bayou Grande. This diagram, Figure 2-1, provides an overview of all identified remedial investigation (RI) sites, spill locations, and petroleum sites assessing the most likely point(s) of discharge into the bay. Pertinent information is summarized in Table 2-1.



PETROLEUM SITES POTENTIALLY IMPACTING PENSACOLA BAY[1]

MAP LABEL	SITE NAME	TANKS/SIZE	CONTENTS	GROUNDWATER CONTAMINANTS
UST A	3231W	1/1000 GAL	WASTE OIL, PD-680	TCE, PCE, METHYLENE CHLORIDE
UST B	PWC SITE 4	SLUDGE DISPOSAL	WASTE OIL, JET FUEL	PETROLEUM HYDROCARBONS
UST C	PWC SITE 1	PIPELINE	JP-5	PETROLEUM HYDROCARBONS
UST D	BUILDING 604	UNKNOWN	TCE	CHLORINATED SOLVENTS
UST E	DFM PIPELINE	PIPELINE	DIESEL	NONE
UST F	607NE	2,500 GAL.	WASTE OIL, JET FUEL	LEAD
UST G	2662W	1000 GAL.	USED OIL, JP-5	BTEX
UST H	3557	2,500 GAL.	WASTE OIL	NONE
UST J	3430	1,000 GAL. TANKS/UNKNOWN SIZE	DIESEL, WASTE OIL, TCE	UNKNOWN
UST K	2459	MULTIPLE/1000 GAL.	GASOLINE	UNKNOWN
UST L	PWC SITE 3/3810N	1,500 GAL.	FUEL OIL	TPHss, PAHs
UST M	3644	2/8000 GAL.	DIESEL	PETROLEUM HYDROCARBONS
UST N	709NS	2/2000 GAL.	FUEL OIL	UNKNOWN
UST O	647, 648, 649, 692	3/1000 GAL., 3/500 GAL.	WASTE OIL, KEROSENE	UNKNOWN
UST P	UST 18	OPEN PITS	JET FUEL, WASTE OIL	BTEX, LEAD
UST Q	SITES 1 TO 13	AVGAS LINE AND 12 TANKS/500 GAL.	JET FUEL	LEAD, PETROLEUM HYDROCARBONS
UST R	RADAR SITE 3255	1/300 GAL.	DIESEL	PETROLEUM HYDROCARBONS
UST S	3212	1/1,000 GAL.	WASTE OIL, WATER TAINTED JP-5	BTEX
UST T	SITE 16	PIPELINE	JET FUEL	PETROLEUM HYDROCARBONS
UST U	SITE 20	1/1,511,580 GAL., AST	JP-5	PETROLEUM HYDROCARBONS
UST V	SITE 26	UNKNOWN	JET FUEL	PETROLEUM HYDROCARBONS
UST W	SITE 23	UNKNOWN	JET FUEL	PETROLEUM HYDROCARBONS
UST W	SITE 26	UNKNOWN	JET FUEL	PETROLEUM HYDROCARBONS
UST X	SITE 27	UNKNOWN	JET FUEL	PETROLEUM HYDROCARBONS

SPILLS FROM NAS PENSACOLA ENVIRONMENTAL SITES[3]

SITE	NATURE OF SPILL	YEAR
3	FUEL FROM THE CRASH CREW TRAINING AREA	1955–PRESENT
15	PESTICIDE RINSATE FROM THE GOLF COURSE	1963–1979
17	PCBs FROM TRANSFORMERS STORED AT SITE	ONGOING
18	PCBS FROM A RUPTURED TRANSFORMER	1967
19	FUEL OIL FROM A PIPELINE BREAK	1958
20	FUEL OIL FROM A PIPELINE LEAK	1981
22	DISPOSAL OF FUEL FROM REFUELER TRUCKS	1958–1977
23	FUEL OIL FROM A PIPELINE BREAK	1965
24	PESTICIDES FROM A DOT MIXING AREA	1960s
25	WASTE FROM RADIUM REMOVAL	1978
26	LEAKS FROM CHEMICAL CONTAINERS	1956–1964
28	TRANSFORMER OIL SOLVENTS AND LEAKED	1981
29	OAK BURNS FROM A SUBSTANCE IN SOIL	1969
OU-10	80,000 GALLONS OF INDUSTRIAL WASTE	1979
	SULFURIC ACID SPILL	1989
	FUEL OIL FROM THE BILGE WATER PLANT	1992
30	WASTE DUMPED INTO NEARBY WETLANDS	1940s–1960s
34	SOLVENT DETERGENT SPILL	1980s
44	PAINTS/SOLVENTS STORED AT BUILDING 3380	1972–1981
36	SOLVENTS/METAL PLATING WASTES	1972–1979

POTENTIAL IMPACTS TO PENSACOLA BAY FROM SOIL/GROUNDWATER[2] CONTAMINANTS AT NAS PENSACOLA SITES INVESTIGATED BY E/A&H

SITE	SOIL CONTAMINANTS	GROUNDWATER CONTAMINANTS	IMPACT
1	METALS, PCBs, SVOCs	METALS, SVOAS, VOAs	BAYOU GRANDE
3	METALS, PESTICIDES, SVOCs, VOCs	METALS, SVOAs, VOAs	PENSACOLA BAY, BAYOU GRANDE (FROM STORM DRAINS)
5	(NO EXCEEDANCES)	METALS	BAYOU GRANDE
8	METALS, PESTICIDES, SVOCs	METALS	BAYOU GRANDE (FROM STORM DRAINS)
10	METALS, PESTICIDES, SVOCs	METALS	BAYOU GRANDE
11	METALS	METALS	BAYOU GRANDE
11	METALS, PCBs, SVOCs	METALS, PESTICIDES	BAYOU GRANDE
12	METALS, PESTICIDES, PCBs, SVOCs	METALS, PESTICIDES	BAYOU GRANDE
13	METALS	METALS	PENSACOLA BAY
14	METALS	METALS	PENSACOLA BAY
15	METALS,PBS,SVOCs	METALS	BAYOU GRANDE
16	METALS, PESTICIDES, SVOCs	METALS	BAYOU GRANDE
17	METALS, PESTICIDES, PBS, SVOCs	METALS	BAYOU GRANDE (FROM STORM DRAINS)
18	METALS, PBS, SVOCs	METALS	BAYOU GRANDE
19	METALS, PESTICIDES, PBS, SVOCs	METALS	PENSACOLA BAY (FROM STORM DRAINS)
25	METALS, PESTICIDES	METALS	BAYOU GRANDE
26	SVOCs	METALS, SVOAs, VOAs	BAYOU GRANDE
27	METALS, PESTICIDES, SVOCs	METALS, RADIATION	BAYOU GRANDE
28	METALS, SVOCs	METALS, SVOAs, VOAs	PENSACOLA BAY
29	METALS, PESTICIDES, SVOAs	(OW NOT INVESTIGATED)	BAYOU GRANDE
30	METALS, PESTICIDES, PBS, SVOCs	METALS, PESTICIDES	BAYOU GRANDE
31	METALS, SVOCs, PESTICIDES	METALS, PESTICIDES, SVOAs, VOAs	PENSACOLA BAY, BAYOU GRANDE
32	METALS, SVOCs, PESTICIDES	METALS, VOLATILES	PENSACOLA BAY, BAYOU GRANDE
33	METALS, SVOCs, PESTICIDES	METALS, SVOAs	PENSACOLA BAY
34	(NO SURFACE SOIL CONTAMINANTS)	METALS, SVOAs	
38	METALS, PESTICIDES, PBS, SVOCs	METALS, SVOCs, VOAs	PENSACOLA BAY
39			PENSACOLA BAY

REFERENCES:

1. PETROLEUM SITE INFORMATION BASED ON REPORTS FROM ABB ENVIRONMENTAL SERVICES, INC. AND PUBLIC WORKS CENTER, NAS PENSACOLA.
2. IRP AND OTHER ENVIRONMENTAL SITE INFORMATION BASED ON ENSAFE/ALLEN & HOSHALL REPORTS.
3. SPILLS INFORMATION BASED ON NEESA, 1983 AND HISTORICAL DATA COMPILED IN E/A&H SITE SPECIFIC IR REPORTS.

LEGEND

- IRP SITE
- PETROLEUM SITE OR UNDERGROUND STORAGE TANK
- WETLAND
- SURFACE DRAINAGE DISCHARGE POINT, BASED ON DRAINAGE BASIN ANALYSIS
- STORM WATER OUTFALL PIPE
- SURFACE SPILL
- SEDIMENT SAMPLE
- ESTUARINE AQUATIC BED
- SITE 36

A – LEPTOCHEIRUS 10–DAY TOXICITY TEST
B – BENTHIC DIVERSITY
C – NEANTHES 20–DAY TOXICITY TEST
D – MYSIDOPIS 7–DAY TOXICITY TEST
E – WATER QUALITY
F – BODY BURDEN ANALYSIS FISH

800 0 800
SCALE FEET

NAVFAC Naval Facilities Engineering Command SOUTHERN DIVISION

SITE 40
ROD
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 2–1
CONTAMINANT SOURCES , ECOLOGICALLY SENSITIVE AREAS, AND SAMPLING LOCATIONS

Dr by: K. BRONSON		Tr by:	
Ck by: C. TRIPLETT		App by: S. PARKER	Sheet 1
Date: 01/22/04	DWG Name:0083G005		Of 1

Table 2-1
NAS Pensacola Sites Relative to Assessment Zones in Bayou Grande

Assessment Zone	Potential Source Site	Significant Pathway Descriptions	Suspected Contaminants
1	3	Surface water runoff through Wetlands 39, 70, 27, 25, and 28	Metals, VOCs
2	1	Surface water and groundwater discharge through Wetlands 15, 16, 17, 18, and 4; groundwater discharge directly to bayou	Metals, VOCs, SVOCs, Pesticides/PCBs
3	1	Golf Course, Site 1 through Wetlands 3 and 4, and Wetland 65	Metals, SVOCs, Pesticides
4	9-13, 29, 30, 36, and OU 10	Discharge into Yacht Basin Wetlands 64, 7, 8, 4, and 5. Golf course runoff.	Metals, VOCs, SVOCs, Pesticides/PCBs

Notes:
OU 10 = Operable Unit 10 (Sites 32, 33, and 35)
VOCs = Volatile organic compounds
SVOCs = Semivolatile organic compounds
PCBs = Polychlorinated biphenyls

Collard (1991) summarizes the environmental-biological history of the PBS, documenting published as well as previously unpublished data from numerous studies conducted since the 1950s to identify biological trends and help understand the current status of the PBS. These studies, which used varying sampling methods, locations, and analytical procedures, were presented in the work plan for Sites 40 and 42. Collard's biological trends analysis concluded that the data did not support distinct, discernible trends, and the database has significant deficiencies. Studies of the Pensacola Bay System, near and within Bayou Grande, are summarized below.

1982-1985 Florida Department of Environmental Protection (FDEP) — Sediment samples collected from Pensacola Bay's turning basin south of the waterfront, Big Lagoon, and the mouth of Bayou Grande had elevated concentrations of mercury and lead. Ratios of Total Kjeldahl Nitrogen to Total Organic Carbon (TOC) indicated nitrogen-enriched sediments in the turning basin and at the mouth of Bayou Grande.

1993 National Oceanographic and Atmospheric Administration (NOAA) — FDEP Study — Within the upper reach, central bayou, and mouth of Bayou Grande, three mid-channel stations were sampled. Elevated concentrations of arsenic, cadmium, chromium, mercury, lead, and zinc were found. Polynuclear aromatic hydrocarbon (PAH) concentrations were not significant.

3.0 COMMUNITY PARTICIPATION

Throughout the site's history, the community has been kept abreast of activities in accordance with CERCLA Sections 113(k)(2)(B)(i-v) and 117. In January 1989, a technical review committee (TRC) was formed to review recommendations for and monitor progress of the investigation and remediation efforts at NAS Pensacola. The TRC included representatives of the Navy, USEPA, FDEP, and the local community. In addition, a mailing list of interested community members and organizations was established and maintained by the NAS Pensacola Public Affairs Office. In July 1995, a Restoration Advisory Board (RAB) was established as a forum for communication between the community and decision-makers. The RAB absorbed the TRC and added members from the community and local organizations. Its members work together to monitor progress of the investigation and to review remediation activities and recommendations at NAS Pensacola. Regularly held RAB meetings are advertised and open to the public.

After finalizing the RI report, the preferred alternative for OU 15 (Site 40) was presented in the Proposed Remedial Action Plan (PRAP), also called the Proposed Plan. A copy was sent to everyone on the NAS Pensacola mailing list. The notice of availability of the Proposed Plan and RI documents were published in the *Pensacola News Journal* on May 23, 2004, followed by a public comment period from May 23, 2004, to July 6, 2004, to encourage public participation in the remedy-selection process. The opportunity for a public meeting was provided during the comment period.

4.0 SCOPE AND ROLE OF THE OPERABLE UNIT

The proposed remedial action identified in this document is the "no-action alternative." No action is proposed for OU 15 (Site 40) because it does not pose an unacceptable risk to human health and the environment. This remedy is the first and final remedial action planned for OU 15 (Site 40).

This is the only Record of Decision (ROD) contemplated for OU 15 (Site 40). This OU is one of 13 operable units within NAS Pensacola. The purpose of each operable unit is defined in the *FY 2004 Site Management Plan* (SOUTHNAVFACENGCOM, 2003) for NAS Pensacola, which is in the Administrative Record. Separate investigations and assessments are being conducted for the other operable units at NAS Pensacola in accordance with CERCLA. Therefore, this ROD applies only to OU 15.

5.0 SITE CHARACTERISTICS

For ease of assessment and discussion, the RI separated the OU 15 study area into four assessment zones (AZs): AZ-1, AZ-2, AZ-3, and AZ-4, as shown in Figure 2-1. Summary of each zone is as follows:

- **AZ-1** includes portions of the NAS Pensacola shoreline along Bayou Grande from a point near Soldiers Creek to Deepwater Point. Sediments within this zone are mostly fine-grained and characteristic of a low-energy tidal regime. Very few contaminant source areas were identified for this AZ. Potential sources include installation restoration program (IRP) Site 3 and Forrest Sherman Field, which lie south of the zone. Wetlands in this AZ include 39, 70, 27, 25, and 28.

- **AZ-2** extends from Deepwater Point to J. Kee Point and includes Redoubt Bayou. The shoreline in this area is characterized by sandy beaches with shallow, broad, sandy shelves extending out into the bayou in some areas. In these areas, fine-grained sediment is found farther offshore than in AZ-1. The major contributing source to this area is IRP Site 1, potentially contributing inorganics (metals), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and pesticides. Wetlands 15, 16, 17, and 18 (which surround Site 1) discharge into this zone. Wetland W-2, also known as the Southeast Drainage Ditch, conveys storm water from the eastern end of Forrest Sherman Field to the southern end of Redoubt Bayou. W-2 is intersected by an unnamed drainage ditch which passes the southside of Site 16 and conveys surface water from the Barrancas Cemetery area. This intersecting ditch also receives storm water from an outfall draining the NAS Public Works Center (encompassing IRP Sites 8, 17, 22, and 24).

  Other wetlands that discharge into the zone include Wetlands 19, 22, 24, and 68. Contaminants have been detected in some monitoring wells near the shore.

- **AZ-3** extends from J. Kee Point to the Navy Boulevard bridge. Sediments in this zone are similar to those in AZ-2, with areas of sandy bottom parallel to the shoreline or extending into the bayou as bars. Primarily, pesticides from the NAS Pensacola Golf Course may be expected in this area where they were routinely and lawfully applied. Contaminants may have been transported to this zone from Site 1 through Wetlands 3 and 4. A skeet shooting range was formerly on the east side of Site 1. Wetland 65 also discharges into this zone.

- **AZ-4** extends from the Navy Boulevard bridge to the pass connecting Bayou Grande with Pensacola Bay. This area includes Woolsey Bayou and portions of Bayou Grande just north of the Navy Yacht Basin (Buddy's Bayou). The upper reach of the Yacht Basin will be addressed in the Site 41 RI. Sediments in this zone are similar to those in AZ-3, with small areas of sandy bottom along the shore. Pesticides applied to the NAS Pensacola Golf Course are suspected, along with other contaminants from the Yacht Basin's influence. Contaminants suspected in the Yacht Basin include VOCs, SVOCs, pesticides, and inorganics from inland IRP Sites 9 to 13, 29, 30, and 36. In addition, a railroad bridge was formerly in the area.

5.1 Nature and Extent of Contamination

In accordance with the Sites 40 and 42 Phase II work plan and sampling and analysis plan (SAP), 143 locations were sampled along approximately 8.5 miles of Bayou Grande coastline. Phase I assessed areas of deposition and erosion by mapping sediment types. TOC analysis determined that the adsorptive capacity of sediments was generally low across the site, therefore Phase II sampling was conducted along the same grid as Phase I. Figure 2-1 depicts the sediment sampling locations. This section discusses the nature and extent of analytes detected in each AZ during the Phase II investigation.

5.1.1 Assessment Zone 1

Thirty-eight sediment samples were collected from AZ-1 to assess the site conditions. Tables 5-1 through 5-3 summarize the frequency and range of detected concentrations, range of nondetected upper bounds, and average detected concentration. The ecological screening concentration and number of samples greater than the screening concentration are also provided to give the reader a general impression of the level of impact. The sample locations and concentrations above the ecological screening concentration are discussed further in the risk assessment in Section 7.

Table 5-1
Inorganics Detected in AZ-1 Sediments, Phase IIA (mg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
Aluminum	38/38		162 - 32300	8866		
Antimony	6/23	0.13 - 0.71	0.19 - 0.71	0.39	12[a]	
Arsenic	34/38	0.12 - 0.14	0.17 - 18.4	7.4	7.24[a, b]	15
Barium	18/38	0.34 - 16.2	0.3 - 24.8	6.7		
Beryllium	16/38	0.06 - 0.98	0.07 - 1.2	0.67		
Cadmium	18/38	0.12 - 0.55	0.22 - 3.7	1.7	0.676[b]	14
Calcium	38/38		59.5 - 6150	1298		
Chromium	32/38	1.1 - 3.9	0.59 - 176	54.5	52.3[a, b]	14
Cobalt	18/38	0.12 - 0.63	0.13 - 5.6	2.5		
Copper	36/38	0.25 - 0.28	0.26 - 33.6	10.8	18.7[a, b]	13
Iron	38/38		174 - 34400	11055		
Lead	36/38	0.95 - 1.1	0.72 - 97.7	29.8	30.2[a, b]	15
Magnesium	38/38		130 - 10000	2967		
Manganese	38/38		0.54 - 235	57		
Mercury	7/38	0.05 - 0.28	0.21 - 2.2	0.58	0.13[a, b]	7
Nickel	24/38	0.55 - 2.5	0.64 - 16	6.7	15.9[a, b]	1
Potassium	34/38	57.5 - 70.3	46 - 4320	1329		
Selenium	18/38	0.25 - 1	0.32 - 2.8	1.3		
Silver	1/38	0.31 - 1.8	0.3800	0.38	0.733[b]	
Sodium	38/38		711 - 35300	9197		
Thallium	2/38	0.25 - 1.4	0.35 - 3	1.7		
Vanadium	38/38		0.44 - 54.2	16		
Zinc	27/38	1.1 - 14.9	2.3 - 163	64.7	124[a, b]	5

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples.
a = USEPA Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
mg/kg = milligrams per kilogram

Table 5-2
Pesticides/PCBs Detected in AZ-1 Sediment, Phase IIA (µg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
4,4'-DDD	1/36	0.19 - 8.9	1.6000	1.6	1.2 2[b]	1
4,4'-DDE	13/37	0.19 - 2.7	0.99 - 4.4	2.4	2.07[b]	7
Aldrin	3/38	0.095 - 4.3	0.45 - 1.8	0.95		
Aroclor-1260	28/38	2.1 – 21	0.2 – 39	15.9	21.6[a]	9
Dieldrin	6/38	0.19 - 8.9	0.9 - 1.7	1.2	0.715[b]	6
Endosulfan II	1/36	0.19 - 8.9	1.3000	1.3		
Heptachlor	1/36	0.095 - 4.3	0.8100	0.81		
Heptachlor epoxide	3/37	0.095 - 4.3	0.11 – 1	0.48		
alpha-BHC	1/36	0.095 - 4.3	1.3000	1.3		
alpha-Chlordane	6/36	0.095 - 4.3	0.1 - 1.6	0.53		
gamma-BHC (Lindane)	6/36	0.095 - 4.3	0.73 - 1.3	1.1	0.32[b]	6
gamma-Chlordane	1/37	0.095 - 4.3	0.4100	0.41		

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples.
a = USEPA Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = micrograms per kilogram

Table 5-3
SVOCs Detected in AZ-1 Sediment, Phase IIA (µg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
2,4-Dimethylphenol	1/38	380 - 2400	98	98		
2-Methylnaphthalene	1/38	38 - 240	94	94	20.2[b]	1
2-Nitroaniline	1/38	380 - 2400	23	23		
3-Nitroaniline	1/38	920 - 5700	200	200		
4-Chloroaniline	1/21	400 - 2400	61	61		
4-Methylphenol (p-Cresol)	5/38	380 - 2100	29 - 200	120		
4-Nitroaniline	1/38	920 - 5700	140	140		
Benzo(a)pyrene	1/38	38 - 240	85	85	88.8[b]	
Benzo(b)fluoranthene	7/38	38 - 170	91 - 170	120		
Benzo(g,h,i)perylene	1/38	38 - 240	85	85		
Butylbenzylphthalate	9/38	380 - 2100	21 - 170	54		
Di-n-butylphthalate	10/38	380 - 2100	21 - 270	78		
Diethylphthalate	2/38	380 - 2400	23 - 1800	912		
Fluoranthene	8/38	38 - 410	21 - 200	107	113[b]	3
Indeno(1,2,3-cd)pyrene	1/38	38 - 240	76	76		
Naphthalene	7/38	38 - 210	22 - 140	69	34.6[b]	3
Nitrobenzene	1/38	380 - 2400	90	90		
Pyrene	3/38	38 - 210	74 -150	111	153[b]	
bis(2-Ethylhexyl)phthalate (BEHP)	19/38	380 - 2100	21 - 2400	208	182[a,b]	2

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples.
a = USEPA Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = microgram per kilogram

Inorganics detected across AZ-1 do not appear related to NAS Pensacola sites or activities associated with Forrest Sherman Field. Pesticides were generally not detected in AZ-1, but polychlorinated biphenyls (PCBs) were detected frequently. Few SVOC parameters and only one VOC (acetone, a common laboratory contaminant) were detected in AZ-1.

Few contaminant source areas were identified for this AZ. Potential sources include former IRP site (underground storage tank [UST]) 18 and Forrest Sherman Field, which lie south of the zone. However, the UST 18 investigation determined that contaminants were not migrating offsite (E/A&H [EnSafe/Allen & Hoshall], 1996). Wetlands 25 and 27 were used as reference wetlands for the Site 41 investigation because no direct pathway led there from NAS Pensacola sites. It was also determined that no direct pathway led from NAS Pensacola sites to three other wetlands in this AZ (Wetlands 39, 70, and 28), therefore they were not sampled in the Site 41 RI (EnSafe, *in press*). Wetland 72, which drains storm water from the north-central portion of Forrest Sherman Field to Bayou Grande through Wetland 39, was sampled during the Site 41 RI. The Site 41 RI discovered scattered metals concentrations, and a few pesticides and SVOCs in Wetland 72, indicating minimal potential impact on Wetland 39 and Bayou Grande from this drainage source (EnSafe, *in press*). The only other possible sources for AZ-1 are the numerous minor surface water drainage pathways that drain through the minor estuarine wetlands lining the AZ-1 shoreline. These cannot, however, be connected directly to an IRP site or activity on the base.

5.1.2 Assessment Zone 2

Fifty-seven sediment samples were collected from AZ-2 to assess site conditions. Tables 5-4 through 5-7 summarize the frequency and range of detected concentrations, range of nondetected upper bounds, and average detected concentrations.

Most of the detected concentrations at AZ-2 and exceedances of the applicable ecological screening criteria are in the upper reaches of Redoubt Bayou. This area receives surface and storm water from two significant drainage sources: Wetland 19B and Wetland W-2. Wetland 19B is at the downstream end of a surface and storm water drainage feature which drains the area northeast of Sherman Field's main runways. Wetland W-2 is the major storm water conduit from the

Table 5-4
Inorganics Detected in AZ-2 Sediments, Phase IIA (mg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
Aluminum	57/57		148 – 28900	6082		
Antimony	7/33	0.12 - 0.71	0.16 - 4.6	1.1	12[a]	
Arsenic	45/57	0.12 - 1.6	0.14 - 21.8	5.5	7.24[a, b]	14
Barium	45/57	0.36 - 0.89	0.19 - 22.2	5.8		
Beryllium	18/57	0.06 - 0.11	0.08 -1.1	0.71		
Cadmium	21/57	0.12 - 0.26	0.25 - 4.5	1.9	0.676[b]	16
Calcium	57/57		66.4 - 5020	952		
Chromium	57/57		0.62 - 174	34.0	52.3[a,b]	14
Cobalt	26/57	0.12 - 0.34	0.12 - 5.2	1.8		
Copper	49/57	0.24 - 0.28	0.27 - 40.1	10.1	18.7[a, b]	14
Iron	57/57		163 - 34400	8109		
Lead	53/57	1.2 - 1.8	0.74 - 131	31.1	30.2[a, b]	16
Magnesium	57/57		138 - 9520	2107		
Manganese	57/57		0.46 - 249	42.19		
Mercury	9/57	0.05 - 0.31	0.08 - 0.64	0.27	0.13[a, b]	8
Nickel	22/57	0.54 - 1	0.63 - 15.4	7.2	15.9[a, b]	
Potassium	50/57	66.3 - 95.2	48.1 - 3790	862		
Selenium	18/57	0.18 - 1.1	0.21 - 2.2	1.2		
Silver	1/57	0.24 - 1.5	0.3200	0.32	0.733[b]	
Sodium	57/57		736 - 31900	6236		
Thallium	3/57	0.18 - 1.6	0.6 - 1	0.84		
Vanadium	57/57		0.40 - 54.4	11.6		
Zinc	38/57	0.86 - 4.5	1.2 - 206	56.8	124[a, b]	11

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples.
a = USEPA Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
mg/kg = milligrams per kilogram

Table 5-5
Pesticides/PCBs Detected in AZ-2 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Ecological Screening Concentration	Number Over Screen
4,4'-DDD	18/56	0.21 - 9.8	0.26 - 16	4.1	1.22[b]	10
4,4'-DDE	25/56	0.21 - 0.81	0.22 - 13	3.2	2.07[b]	13
4,4'-DDT	17/56	0.18 - 9.8	0.21 - 22	3.1	1.19[b]	5
Aldrin	9/56	0.088 - 4.8	0.22 - 1.8	0.81		
Aroclor-1242	8/56	1.8 - 98	1.8 - 34	8.2	33[b]	1
Aroclor-1260	28/56	2.1 - 19	1.2 - 110	31.5	33[b]	16
Dieldrin	18/56	0.18 - 9.8	0.11 - 2.6	0.99	0.715[b]	8
Endosulfan I	3/56	0.088 - 4.8	0.11 - .12	0.12		
Endosulfan II	4/56	0.18 - 9.8	0.43 - 1.1	0.69		
Endosulfan sulfate	1/56	0.18 - 9.8	0.41	0.41		
Endrin	9/56	0.18 - 9.8	0.14 - 1.4	0.83	3.3[a]	
Endrin aldehyde	1/56	0.18 - 9.8	0.41	0.41	3.3[a]	
Endrin ketone	5/56	0.18 - 9.8	0.11 - 1.6	0.76	3.3[a]	
Heptachlor epoxide	3/56	0.088 - 4.8	0.15 - 2.5	1.2		
Methoxychlor	1/56	0.88 - 48	1.9000	1.9		
alpha-BHC	6/56	0.1 - 4.8	0.15 - 1.8	0.67		
alpha-Chlordane	12/56	0.1 - 4.8	0.12 - 1.5	0.75		
beta-BHC	2/56	0.088 - 4.8	0.19 - .38	0.29		
gamma-BHC (Lindane)	15/56	0.088 - 0.55	0.11 - 2.3	0.94	0.32[b]	10
gamma-Chlordane	5/56	0.088 - 4.8	0.21 - 1.4	0.82		

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples.
a = USEPA Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = micrograms per kilogram

Table 5-6
SVOCs Detected in AZ-2 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentrations	Ecological Screening Concentration	Number Over Screen
2,2'-oxybis(1-Chloropropane)	1/55	400 - 9100	44	44		
2-Methylnaphthalene	1/55	40 – 910	160	160	20.2[b]	1
4-Methylphenol (p-Cresol)	1/55	400 - 9100	78	78		
Acenaphthene	1/55	19 – 440	33	33	6.71[b]	1
Anthracene	1/55	40 – 910	80	80	46.9[b]	1
Benzo(a)anthracene	13/57	40 -910	22 – 230	103	74.8[b]	6
Benzo(a)pyrene	16/57	40 – 910	25 – 260	111	88.8[b]	7
Benzo(b)fluoranthene	21/57	40 – 910	22 – 380	131		
Benzo(g,h,i)perylene	10/57	40 – 910	60 – 240	110		
Benzo(k)fluoranthene	9/57	40 – 910	39 – 180	110		
Butylbenzylphthalate	8/55	400 - 9100	28 – 160	81.4		
Carbazole	1/55	400 - 9100	69.0000	69		
Chrysene	13/57	40 – 910	23 – 290	116	108[b]	6
Di-n-butylphthalate	20/56	400 -9100	18 – 110	41.6		
Dibenz(a,h)anthracene	1/55	40 – 910	42	42	6.22[b]	1
Diethylphthalate	3/55	400 -9100	24 - 30000	10375		
Fluoranthene	21/57	40 -910	22 – 490	147	113[b]	9
Fluorene	1/55	19 – 440	34	34	21.2[b]	1
Indeno(1,2,3-cd)pyrene	7/57	40 – 910	40 – 210	110		
Naphthalene	2/55	40 – 910	21 – 130	75.5	34.6[b]	1
Phenanthrene	7/56	40 – 910	20 – 260	104	86.7[b]	4
Phenol	4/55	400 - 9100	22 – 160	56.5		
Pyrene	17/57	40 – 910	31 – 480	163	153[b]	6
bis(2-Ethylhexyl)phthalate (BEHP)	9/55	69 - 9100	27 - 1500	258	182[a,b]	2

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples.
a = USEPA Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = micrograms per kilogram

Table 5-7
VOCs Detected in AZ-2 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Acetone	21/57	12 – 580	18 - 1200	226		
Carbon disulfide	1/57	11 -83	12	12		
Chloromethane	1/57	11 -83	1	1		
Methylene chloride	4/57	11 -83	3	8.5		

Note:
µg/kg = micrograms per kilogram

eastern portion of Forrest Sherman Field. W-2 also receives surface and storm water from the Barrancas Cemetery area and the Public Works Center area. The Public Works Center area contains a PCB site (Site 17), a petroleum program site (UST Site 26, designated as UST W on Figure 2-1), a DDT mixing area (Site 8), and a pesticide site (Site 24). These sites have already been investigated and are currently undergoing various stages of investigation or remediation. Site 17 underwent an interim soil removal and was approved for no-action. Inorganic and organic compounds were detected in Site 8 soil. Site 24 soil samples had detections of inorganic compounds (arsenic, aluminum, iron, and manganese), pesticides (dieldrin, aldrin, and heptachlor epoxide), and SVOCs (benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene). Site 22 was transferred to the petroleum program and became UST Site 26. Benzene was detected in groundwater at this site. Impacts to groundwater were limited vertically to the shallow surficial aquifer and laterally to the center of the site. Geochemical data show that natural attenuation is occurring, and monitored natural attenuation is the FDEP-approved alternative for this site.

Inorganic and organic parameters detected in sediments from Wetlands W-2 and 19B were also detected in sediments from the upper reaches of Redoubt Bayou. Over the years, major storm events have likely flushed contaminants through Wetlands W-2 and 19B into the upper end of Redoubt Bayou, where these elements and compounds have accumulated. Since Redoubt Bayou is a sheltered arm of Bayou Grande, tidal and storm currents probably do not flush this area very much; this likely has facilitated the buildup of these contaminants over time.

5.1.3 Assessment Zone 3

Twenty-four sediment samples were collected from AZ-3 to assess the site conditions. Tables 5-8 through 5-11 summarize the frequency and range of detected concentration of nondetected upper bounds, and average detected concentrations.

Metal exceedances were mostly distributed between three samples (Z302, Z319, and Z323). PCBs were evenly distributed throughout the sample population for AZ-3, but were mostly detected below applicable ecological screening criteria. Pesticide and SVOC detections were focused at the

Table 5-8
Inorganics Detected in AZ-3, Phase IIA (mg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Aluminum	24/24		163 - 27400	3171		
Antimony	3/10	0.13 - 0.68	0.15 - 0.45	0.34	12[a]	
Arsenic	18/24	0.13 - 0.35	0.18 - 17.5	2.8	7.24[a, b]	3
Barium	22/24	0.06 - 0.61	0.19 - 21.6	2.9		
Beryllium	5/24	0.06 - 0.08	0.11 - 1.4	0.68		
Cadmium	7/24	0.13 - 0.24	0.2- 7.1	2.24	0.676 [b]	4
Calcium	24/24		77.5 - 17500	1892		
Chromium	24/24		0.83 - 238	26.4	52.3[a, b]	4
Cobalt	9/24	0.13 - 0.21	0.16 - 5.3	1.5		
Copper	24/24		0.3-52.2	7	18.7[a, b]	3
Iron	24/24		195 - 38000	4409		
Lead	24/24		2.4 - 134	25.8	30.2[a, b]	6
Magnesium	24/24		135 - 10100	1222		
Manganese	24/24		0.5 - 300	35.5		
Mercury	2/24	0.05- 0.19	0.14 - 0.35	0.24	0.13[a,b]	2
Nickel	6/24	0.58 - 0.97	0.96- 16.6	6.6	15.9[a, b]	1
Potassium	23/24	80.4 - 80.4	37.5 - 3900.	472		
Selenium	5/24	0.19- 0.28	0.36 - 2.1	1.2		
Silver	1/24	0.25 - 1.3	0.3700	0.37	0.733[b]	
Sodium	24/24		687 - 33800	4156		
Thallium	5/24	0.19 - 1	0.23 - 0.38	0.29		
Vanadium	24/24		0.25 - 48.6	5.8		
Zinc	23/24	2.3 - 2.3	1.5 - 224.	25.9	124[a, b]	2

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Screening Concentration for Sediment µ FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
mg/kg = milligrams per kilogram

Table 5-9
Pesticides/PCBs Detected in AZ-3 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
4,4'-DDD	3/24	0.21- 1.2	0.24 - 0.5	0.36	1.22[b]	
4,4'-DDE	10/24	0.21 - 0.67	0.21 - 4.4	1.48	2.07[b]	2
4,4'-DDT	10/24	0.21 - 1.2	0.23 - 1.9	0.7	1.19[b]	2
Aldrin	1/24	0.1 - 0.59	0.32	0.32		
Aroclor-1254	1/24	2.1 - 12.	5.3	5.3	21.6[a]	
Aroclor-1260	13/24	2.1 - 2.2	0.69 – 84	14.4	21.6[a]	3
Dieldrin	4/24	0.21 - 1.2	0.48- 99	26.7	0.715[b]	2
Endosulfan II	1/24	0.21 - 1.2	0.21	0.21		
Endosulfan sulfate	5/24	0.21 - 1.2	0.25 - 1.5	0.84		
Endrin	4/24	0.21- 1.2	0.19 – 3	1.1	3.3[a]	
Endrin ketone	1/24	0.21 - 1.2	1.7	1.7	3.3[a]	
Heptachlor	1/24	0.1 - 0.59	0.11	0.11		
Heptachlor epoxide	1/24	0.1 - 0.59	0.27	0.27		
alpha-BHC	5/24	0.1 - 0.59	0.4 - 1	0.61		
alpha-Chlordane	5/24	0.1 - 0.59	0.11 - 2.3	0.63		
gamma-BHC (Lindane)	1/24	0.1 - 0.59	0.64	0.64	0.32[b]	1
gamma-Chlordane	3/24	0.1 - 0.59	0.1 - 0.75	0.33		

Notes:
a = USEPA Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = micrograms per kilogram

Table 5-10
SVOCs Detected in AZ-3 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
4-Methylphenol (p-Cresol)	1/24	400 - 21000	22.0000	22		
Acenaphthene	2/24	19 - 1000	32 – 10000	5016	6.71[b]	2
Anthracene	4/24	40 - 2100	41 – 5500	1440	46.9[b]	3
Benzo(a)anthracene	20/24	41 - 42	23 – 44000	2524	74.8[b]	11
Benzo(a)pyrene	20/24	40 - 42	21 – 21000	1426	88.8[b]	11
Benzo(b)fluoranthene	22/24	42 - 42	36 – 19000	1419		
Benzo(g,h,i)perylene	19/24	40 - 42	25 – 7700	731		
Benzo(k)fluoranthene	18/24	41 - 49	21 – 16000	1121		
Butylbenzylphthalate	2/24	400 - 21000	27 – 180	104		
Carbazole	2/24	400 - 21000	36 – 61	49		
Chrysene	21/24	42 - 42	25 – 44000	2451	108[b]	11
Di-n-butylphthalate	10/24	410 - 21000	21 – 160	41		
Dibenz(a,h)anthracene	3/24	40 - 2100	25 – 77	58	6.22[b]	3
Fluoranthene	21/24	42	26 – 52000	2881	113 [b]	11
Fluorene	1/24	19 - 1000	7900.0000	7900	21.2[b]	1
Indeno(1,2,3-cd)pyrene	19/24	40 - 42	22 – 7500	675		
Naphthalene	2/24	40 - 2100	23 – 35	29	34.6[b]	1
Phenanthrene	15/24	41 - 130	27 – 25000	1862	86.7[b]	7
Pyrene	21/24	42	25 – 89000	4640	15[3b]	9
bis(2-Ethylhexyl)phthalate (BEHP)	8/24	400 - 21000	28 – 280	81	182[a, b]	1

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = micrograms per kilogram

Table 5-11
VOCs Detected in AZ-3 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Acetone	7/23	12 - 430	14 - 150	52		
Carbon disulfide	2/23	11 - 71	6 - 23	15		

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples.
µg/kg = micrograms per kilogram

discharge points for Wetlands 4D and 65, and at the south landing for the bridge leading to NAS Pensacola. Because these two wetlands are conduits for surface and storm water from the NAS golf course, normal pesticide application and operation of maintenance vehicles account for these pesticide and SVOC distributions. Vehicle traffic and storm water runoff from the bridge account for the SVOCs detected in samples collected next to the southern bridge landing at the base. The skeet shooting range area on the east side of Site 1 was also sampled, and elevated levels of lead were not detected.

5.1.4 Assessment Zone 4

Twenty-four sediment samples were collected from AZ-4 to assess the site conditions. Tables 5-12 through 5-15 summarize the frequency and range of detected concentrations of nondetected upper bounds, and average detected concentrations.

Most of the metals exceeding criteria at AZ-4 (including arsenic, cadmium, chromium, copper, lead, and zinc) were distributed within the middle to lower reaches of Woolsey Bayou. Pesticide and SVOC detections and exceedances at AZ-4 were found mainly in Woolsey Bayou as well as was the single PCB exceedance. Woolsey Bayou is a small arm of Bayou Grande west of the Yacht Basin, between the Yacht Basin and the main bridge leading to NAS Pensacola. In addition to the main bridge, a railroad bridge was formerly in this vicinity and may have contributed to the SVOC detections. This area of AZ-4 receives minor storm water runoff from the easternmost fairway of the NAS golf course and Murray Road. A single storm water outfall draining the northeast portion of the base also discharges into Woolsey Bayou. However, no sites are near Woolsey Bayou, nor does it receive storm water runoff from any sites as the Yacht Basin does from OUs 2, 6, 10, and Site 10 via the stream that flows through Wetland 6. Woolsey Bayou is not flushed by a stream, nor is it periodically dredged like the Yacht Basin. This area is sheltered from the main body of Bayou Grande, and tidal and storm current flushing is minimal. The lack of consistent or strong currents in Woolsey Bayou likely allows contaminants to build up in sediments, which may account for the fact that Woolsey Bayou contains more parameters above ecological screening values than does the Yacht Basin.

Table 5-12
Inorganics Detected in AZ-4 Sediments, Phase IIA (mg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Aluminum	24/24		23.5 - 217	2133		
Antimony	1/4	0.14 - 0.24	0.14	0.14	12[a]	
Arsenic	9/24	0.13 - 0.99	0.24 - 15.3	4.2	7.24[a,b]	2
Barium	19/24	0.16 - 0.85	0.17 - 18.3	2.5		
Beryllium	4/24	0.06 - 0.08	0.26 - 1.2	0.63		
Cadmium	10/24	0.19 - 0.22	0.28 - 5.1	1.4	0.676 [b]	4
Calcium	24/24		51.5 - 9200	1254		
Chromium	23/24	0.53	0.62 - 177	21.1	52.3[a,b]	3
Cobalt	9/24	0.19 - 0.24	0.21 - 3.5	1.2		
Copper	20/24	0.27 - 1.3	0.47 - 46.9	6.1	18.7[a,b]	2
Iron	24/24		33.6 - 309	3178		
Lead	22/24	0.59 - 1.1	1.2 - 107	13.7	30.2[a,b]	4
Magnesium	24/24		123 - 9010	974.0		
Manganese	24/24		0.19 - 235	27.40		
Mercury	2/24	0.05 - 0.31	0.14 - 0.24	0.19	0.13[a,b]	2
Nickel	8/24	0.64 - 0.96	0.84 - 10.7	3.2	15.9[a,b]	
Potassium	23/24	81.3	44.8 - 3460	393		
Selenium	4/24	0.19 - 0.29	0.47 - 1.9	1.2		
Silver	1/24	0.25 - 1.3	0.33	0.33	0.733[b]	
Sodium	24/24		619 - 31600	3797		
Thallium	5/24	0.19 - 1	0.27 - 0.98	0.49		
Vanadium	20/24	0.29 - 0.54	0.37 - 40.6	5.1		
Zinc	19/24	1.2 - 3	2 - 187	27.7	124[a,b]	1

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
a = USEPA Ecological Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Ecological Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
mg/kg = milligrams per kilogram

Table 5-13
Pesticides/PCBs Detected in AZ-4 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
4,4'-DDD	3/22	0.21 - 1.1	0.26 - 1.3	0.64	1.22[b]	1
4,4'-DDE	4/22	0.21 - 0.26	0.23 - 1.6	0.98	2.07[b]	
4,4'-DDT	4/22	0.21 - 1.1	0.31 - 1.3	0.57	1.19[b]	1
Aroclor-1254	4/23	2.1 – 11	2.3 - 8.5	6.3	21.6[a]	
Aroclor-1260	13/21	2.1 – 14	1.0 – 120	12.3	21.6[a]	1
Dieldrin	4/22	0.21 - 0.26	0.24 - 2.2	1.0	0.715[b]	2
Endosulfan II	4/22	0.21 - 0.73	0.39 - 3.1	1.2		
Endosulfan sulfate	2/21	0.21 - 0.73	0.25 - 1.2	0.73		
Endrin	4/22	0.21 - 1.10	0.86 - 3.9	2.1	3.3 [a]	1
Endrin aldehyde	1/21	0.21 - 1.10	0.60	0.60	3.3[a]	
Heptachlor	1/21	0.10 - 0.54	0.11	0.11		
alpha-BHC	10/22	0.10 - 0.54	0.13 - 2.90	0.61		
alpha-Chlordane	4/21	0.10 - 0.54	0.13 - 0.45	0.22		
beta-BHC	1/21	0.10 - 0.54	0.24	0.24		
gamma-BHC (Lindane)	4/23	0.10 - 0.54	0.16 - 9.20	2.9	0.32[b]	3
gamma-Chlordane	3/22	0.10 - 0.54	0.11 - 0.29	0.21		

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples.
a = USEPA Ecological Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Ecological Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = micrograms per kilogram

Table 5-14
SVOCs Detected in AZ-4 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
2,4-Dimethylphenol	1/24	400 - 1400	37	37		
2-Methylnaphthalene	2/24	40 - 140	25 – 59	42	20.2[b]	2
4-Methylphenol (p-Cresol)	2/24	400 - 1400	31 – 82	57		
Acenaphthene	1/24	19 - 68	35	35	6.71[b]	1
Acenaphthylene	1/24	40 - 410	100	100	5.87[b]	1
Anthracene	1/24	40 - 420	120	120	46.9[b]	1
Benzo(a)anthracene	11/24	40 - 46	22 – 530	120	74.8[b]	5
Benzo(a)pyrene	9/24	40 - 46	21 – 470	133	88.8[b]	4
Benzo(b)fluoranthene	15/24	40 - 42	26 – 660	133		
Benzo(g,h,i)perylene	5/24	40 - 46	57 – 340	183		
Benzo(k)fluoranthene	6/24	40 - 46	21 – 310	133		
Butylbenzylphthalate	2/24	400 - 1400	30 – 39	35		
Carbazole	1/24	400 - 1400	62	62		
Chrysene	11/24	40 - 46	27 – 630	139	108[b]	5
Di-n-butylphthalate	10/24	400 - 510	26 – 90	43		
Fluoranthene	15/24	40 - 42	28 – 1100	185	113[b]	5
Fluorene	1/24	19 - 68	55	55	21.2[b]	1
Indeno(1,2,3-cd)pyrene	5/24	40 - 46	47 – 270	139		
Naphthalene	2/24	40 - 140	35 – 80	58	34.6[b]	2
Phenanthrene	9/24	40 - 46	24 – 460	119	86.7[b]	4
Pyrene	15/24	40 - 42	25 – 1100	176	153[b]	5
bis(2-Ethylhexyl)phthalate (BEHP)	2/24	400 - 1400	43 – 91	67	182[a, b]	

Notes:
a = USEPA Ecological Screening Concentration for Sediment — USEPA SSVs as listed in *Supplemental Guidance to RAGS: Region 4 Bulletins — Ecological Screening Values (Sediment Screening Values)* USEPA Region 4, Atlanta, GA, (November 1995)
b = FDEP Ecological Screening Concentration for Sediment — FDEP SQAGs as listed in the *Approach to the Assessment of Sediment Quality in Florida Coastal Waters* by D.D. MacDonald, MacDonald Environmental Sciences, Ltd., Prepared for the Florida Department of Environmental Protection, November 1994.
µg/kg = micrograms per kilogram

Table 5-15
VOCs Detected in AZ-4 Sediments, Phase IIA (µg/kg)

Parameter	Frequency of Detection*	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Averaged Detected Concentration	Ecological Screening Concentration	Number Over Screen
Acetone	7/23	12 - 130	10 - 380	73		
Carbon disulfide	3/23	12 - 14	5 - 46	20		
Chlorobenzene	2/23	12 - 43	3 - 5	4		
Methylene chloride	1/23	12 - 43	22	22		
Tetrachloroethene	1/23	12 - 43	2	2		

Notes:
* = For specific parameters, the total number of samples has been reduced by the number of rejected samples. See Section 8 of this report.
µg/kg = micrograms per kilogram

5.2 Fate and Transport

During preparation of the Nature and Extent section of the RI report, contamination was defined as an exceedance of Sediment Quality Screening Values. However, this is based on ecological effects and may not account for the physical and chemical relationships between cross-media or intra-media transport. This section evaluates the dominant transport mechanisms in the Bayou and develops appropriate screening methods for evaluating the validity of those mechanisms.

The significance and direction of sediment redistribution can generally be evaluated using appropriate landform indicators. Partitioning of contamination from sediment to surface water is significantly less predictable. The mechanisms governing sediment to water partitioning are complex, and at this point require a screening tool for further analysis of Bayou Grande sediments.

USEPA provides a basis for evaluating soil-to-groundwater cross-media transport in *Soil Screening Guidance* (USEPA 1996). Because the process of sediment to surface water partitioning is governed by the same general principles, this analysis utilizes the principles presented in that document to derive quantitative Sediment Screening Levels (SSLs). These are defined as conservative concentrations of a given parameter that can leach from sediment to surface water. The theory behind the partitioning equation, as well as appropriate considerations and limitations regarding the partitioning principles, are included in *Soil Screening Guidance* and are not repeated here. The SSLs calculated in the RI are presented in Table 5-16; for more information see Section 9 of the RI report.

Contaminant Transport Mechanism Validation

This section evaluates the detections with respect to the transport mechanisms defined in the previous section.

Table 5-16
Calculated Sediment Screening Levels for Bayou Grande
NAS Pensacola Site 40

Parameter	USEPA or FDEP Surface Water Standard	Kd	SSL DF = 100	Maximum Concentration Detected	Leaching Potential DF = 100
Inorganics	**(ppb)**		**(ppm)**	**(ppm)**	
Arsenic	50	2.9E+01	148	21.8	NO
Cadmium	9.3	7.5E+01	70	7.1	NO
Chromium	673,000	1.9E+01	1,323,500	236	NO
Copper	2.9	4.3E+02	125	52.2	NO
Lead	5.6	9E+02	504	134	NO
Mercury	.025	5.2E+01	.13	2.2	YES
Zinc	86	6.2E+01	539	224	NO
Nickel	8.3	6.5E+01	54.5	18.9	NO
Organics	**(ppb)**		**(ppb)**	**(ppb)**	
4,4 DDE	0.14	5.68E+04	795,200	4.4	NO
4,4 DDD	.025	1.27E+04	31,751	1.6	NO
4,4 DDT	.001	3.34E+04	3,340	1.9	NO
Dieldrin	.0019	2.72E+02	51.8	99	YES
Endrin	.0023	1.56E+02	36	3.9	NO
Gamma BHC	.016	1.36E+01	22.8	9.2	NO
2-methyl naphthalene	NA	9.52E+01	NA	160	NO
Anthracene	110	3.75E+02	4,132,326	5500	NO
Acenapthylene	.031	3.94E+01	124	100	NO
Total PCBs	.031	3.92E+03*	12,154	84	NO
Acenapthene	2.7	9.91E+01	26,937	1000	NO
Benzo(a)anthracene	.031	5.05E+03	15,657	4,400	NO
Benzo(a)pyrene	.031	1.3E+04	40,302	21,000	NO
Chrysene	.031	5.05E+03	15,657	44,000	YES
Dibenzo(a)anthracene	.031	4.83E+04	149,732	77	NO
Fluoranthene	.37	1.36E+03	50,345	52,000	YES
Fluorene	NA	1.75E+02	NA	7,900	NO
Napthalene	23.5	7.92E+02	1,862,765	140	NO
Phenanthrene	.031	3.81E+02	1,183	25,000	YES
Pyrene	11	1.33E+03	1,463,700	89,000	NO
Bis(2-ethyl hexyl)phthalate	NA	1.92E+05	NA	2,400	NO

Notes:
* = based on Aroclor-1260
Kd = normalized partitioning coefficient
Kd for organics calculated using an organic carbon fraction (foc) of 0.0127 (numerical average of all sediment samples).
Kds are from: USEPA, 1996 (first preference); *Superfund Chemical Data Matrix,* 1996 (second preference); *Texas Risk Reduction Program Concept Document 2, Volume 1, Appendix VII,* 1996 (third preference); TERRA Model, Oak Ridge National Laboratory, 1984 (fourth preference — primary reference for inorganics).
SSL = sediment screening level
DF = dilution factor
ppb = parts per billion
ppm = parts per million
NA = Not Available

Sediment Movement Pathway

As previously evaluated, sediment movement into and within the bayou are valid transport mechanisms within this system. Influx into the system is a clear possibility, but sediment movement within the bayou bears some further analysis. General trends show higher contaminant detections near the previously noted prominences (likely depositional areas) and in samples farther from shore (likely to be associated with finer-grained, higher TOC sediments). Detections also tend to be more frequent in the small southern depositional portion of Redoubt Bayou, along its eastern edge, at the point of entry for Wetland 4, and in the smaller estuarine areas near Magazine Point. Landform distribution (e.g., several prominences indicative of early spit development) suggests current movement and overall sediment load shift is occurring within the bayou. Movement is generally from west to east, toward the mouth of the bayou and its entry into Pensacola Bay. This transport pathway is clearly valid for the bayou, with contaminants expected to coincide with areas of sediment accretion.

Sediment-to-Surface Water Pathway

Overall, only one inorganic parameter (mercury) and four organic parameters (dieldrin, chrysene, fluoranthene, and phenanthrene) exceeded their SSLs. The pathway clearly has merit for these constituents. The distribution of these parameters, with emphasis on remarkable features, is described below.

Inorganics — Mercury was detected above its SSL at seven locations in AZ-1, eight locations in AZ-2, two locations in AZ-3, and two locations in AZ-4. The detections suggest that current hydrodynamics are governing distribution trends. Within the bayou proper, detections were most common in areas of sediment accretion, based on landform analysis. Within Redoubt Bayou, detections were most common in the immediate southern depositional basin, as well as on the eastern side where deposition is most likely to be occurring. Sources for both AZ-2 and AZ-4 are likely associated with the surface drainage features feeding into them.

Organics — Dieldrin was detected above its SSL at only one location in AZ-3. Dieldrin was generally detected immediately north of the airfield in AZ-1, in the southern basin and eastern side

of Redoubt Bayou in AZ-2, at the mouth of Wetland 4 and along the flanks of the golf course in AZ-3, and along the flanks of the golf course in AZ-4. The highest density of detections occurred in the Redoubt Bayou system which is likely associated with maintenance of the airfield complex and surrounding area. The single SSL exceedance was anomalously high relative to the other detections, and is likely associated with pesticide application on the golf course. This single detection above dieldrin's SSL suggests that this may not be a significant pathway for dieldrin.

Chrysene was detected above its SSL at only one location in AZ-3. Chrysene detections were somewhat pervasive in AZs-2, 3, and 4, and are likely associated with fuel combustion (potentially land borne and boating traffic) and storm water runoff. The one exceedance was found immediately outside the main gate, along the corridor used by all land borne traffic entering and leaving the base from the north. Significant trends in the data are ambiguous, but the highest density of detections and the overall highest concentrations were associated with the entry of Wetland 4 into the bayou and the general vicinity of the base's main gate. This single detection above the SSL suggests that this may not be a significant pathway for chrysene.

Fluoranthene was detected above its SSL at only one location in AZ-3. Fluoranthene distributions resemble those for chrysene, indicating a similar provenance. The single exceedance of fluoranthene coincided with that for chrysene, and the highest density of detections and the overall highest concentrations were associated with the entry of Wetland 4 into the bayou and the main gate area. This single detection above the SSL suggests that this may not be a significant pathway for fluoranthene.

Phenanthrene was detected above its SSL at two locations in AZ-3. Although not as pervasive as chrysene, the phenanthrene distribution is similar. One of the exceedances coincided with those for chrysene and fluoranthene, and the other was detected in the Wetland 4 area. Again, the highest density of detections and the overall highest concentrations were associated with the Wetland 4 entry into the bayou and the general area near the main gate. These two detections above phenanthrene's SSL suggest that this may not be a significant pathway for phenanthrene.

6.0 CURRENT AND POTENTIAL FUTURE LAND AND WATER USES

Site 40 and the sailing facility, near the family picnic area, are currently used only for swimming and fishing from shore. Human contact with site sediment and surface water is of short duration, such as during swimming activities. Seasonal water temperatures limit swimming to the warmer months of the year, generally May through September, while fishing and crabbing are year-round activities. Homeland security restrictions prohibit boat traffic within 300 feet of the NAS Pensacola shore which is the area of Site 40.

These submerged lands are owned by the State of Florida. Future land use at NAS Pensacola adjacent to Site 40 will be limited to swimming and fishing outside of the Homeland Security restrictions. Since these lands are submerged, any construction activities in this area would require U.S. Army Corps of Engineer (COE) and FDEP permits and/or approval.

7.0 SUMMARY OF SITE RISKS

During the RI, a Baseline Risk Assessment (BRA), including an ecological risk assessment (ERA) and human health risk assessment (HHRA), was conducted to evaluate actual or potential ecological and human health risks from the no-action scenario at Site 40. The BRA, incorporated into Section 10 of the RI report, represents an evaluation of the no-action alternative, by identifying the risks if no remedial action is taken. The assessment based on RI data considers environmental media and exposure pathways that could result in an unacceptable level of exposure now or in the foreseeable future.

7.1 Ecological Risk Assessment

An ERA was conducted as part of the BRA to develop a qualitative and/or quantitative appraisal of the actual or potential ecological effects from Site 40 contamination. The assessment considers environmental media and potential exposure pathways that could result in unacceptable exposure to flora and fauna now or in the foreseeable future.

Because Site 40 is a marine environment, the ERA focused on two concerns:

1. The possibility that sediment contaminants could impact the overall benthic ecosystem and other lower food-chain organisms.

2. The possibility that primary consumers and organisms higher in the food chain could be exposed, through direct contact or ingestion, to elevated contaminant concentrations in sediment and lower trophic-level food sources.

The approach used to assess human health is a preliminary screening, evaluating exposure potential based on Site 40 physical characteristics and exposure to fish tissue-borne contaminants collected during Phase III sampling.

7.1.1 Phase I Sediment Mapping Results

Sediment distribution in the bayou was mapped to determine areas of highest potential contaminant deposition. As an inlet to Pensacola Bay, Bayou Grande is not subject to as much tidal influence or wave action as the bay itself, which limits sediment migration. Areas of the bayou with the highest percentages of fine-grained material were selected for Phase IIA sediment sampling because they are considered to have received the highest historical contaminant deposition (finer-grained sediments are typical of low-energy depositional areas). Complete Phase I methodology and results are included in the SAP for Sites 40 and 42 (E/A&H, 1995).

7.1.2 Phase IIA Sediment Screening Values

The results of Phase I led to the selection of sampling locations for Phase IIA. To characterize risk to Site 40 receptors, contaminant concentrations from the Phase IIA sediment analysis were compared with sediment quality guidelines. These guidelines are the lower of either the USEPA Region 4 Sediment Screening Values (SSVs) [USEPA, 1995] or the FDEP Sediment Quality Assessment Guidelines (SQAGs) [MacDonald, 1994]. This section describes these screening values, how they were derived, and how they were used in assessing risk at Site 40.

SSVs are based on contaminant concentrations associated with adverse effects on ecological receptors. The Office of Technical Services has developed these for use at USEPA Region 4 hazardous waste sites. Since these values are based on conservative endpoints and sensitive ecological effects data, they represent a preliminary screening of site contaminant levels to determine whether further investigation is needed; they are not remediation levels. Sediment screening values are derived from statistical interpretation of effects databases obtained from the literature, as reported in publications from the State of Florida, NOAA, and a joint publication by Long et al., (1995). These values are based on observations of direct toxicity when available.

SQAGs, developed by MacDonald (1994), are guidelines for evaluating sediment contamination in coastal ecosystems based on a contaminant effects-based data set specific to the state of Florida.

Sediment contamination was assessed in a two-step process. First, each contaminant was compared with the threshold effects level (TEL). Below this level, contaminant concentrations are dominated by no biological effects data and are not considered hazardous to aquatic organisms. Secondly, each contaminant concentration was compared to the probable effects level (PEL), which is usually associated with adverse biological effects. Above this level, contaminant concentrations are considered to pose a risk to aquatic organisms. Between the TEL and PEL, risk to aquatic organisms is possible but not certain.

The SQAGs have weaknesses that were recognized during their development. For example, they do not address the potential for bioaccumulation of persistent toxic chemicals, synergistic effects, or potential adverse effects on higher trophic-level species in the food web. In addition, the lack of consistency among organisms used to develop these data sets could reduce their relevance to species studied at NAS Pensacola. For the remainder of this section, the lower of the USEPA SSV or the Florida SQAG will be referred to as the SSV.

Preliminary Exposure Estimate

Once the appropriate SSVs were compiled, assumptions were made regarding the potential for a receptor to be exposed to site contamination. For estimating exposure to sediment-dwelling organisms, benthic fauna were assumed to live near each sample location. This screening approach also assumed that 100% of the contaminant found would be bioavailable to benthic organisms at that location. Both of these conservative assumptions were used to estimate a chemical's potential effects and, using the following equation, a hazard quotient (HQ) was determined for each contaminant at each sampling location.

Equation 1 $$HQ = \frac{\text{Contaminant Concentration}}{\text{SSV}}$$

An HQ greater than 1 is interpreted by USEPA as a level at which adverse ecological effects are likely to occur. An HQ less than 1, however, does not indicate the absence of risk (USEPA, 1995).

7.1.3 Phase IIA Results

This section evaluates sediment contamination in each AZ at Site 40. Except for certain PAH compounds, all detections were of the same order of magnitude as the screening value. Although metal concentrations were elevated across the bayou, most exceedances were to the west in AZs-1 and 2 as were the pesticide and PCB exceedances. The SSVs for SVOCs were exceeded primarily in AZs-2 and 3 and, based on their distribution, appeared to be associated with storm water discharge points and the former railroad bridge. Overall, the most contaminated area was the southern portion of Redoubt Bayou in AZ-2.

For Site 40, HQs were determined only for contaminants exceeding the SSV. The following paragraphs discuss exceedances and spatial relevance, along with an interpretation of the number of exceedances relative to the sample size for each AZ. For individual HQ values for each sample location, please reference Section 10 of the RI report.

AZ-1

AZ-1 is the farthest upstream of the AZs. As discussed in Section 5, there did not appear to be any distinctive pattern or areas where contaminants were particularly elevated. Within the sediment, HQ values calculated for metals were greater than 1 for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. One HQ value exceeded 10 for mercury at sample location 040MZ130. Pesticides and PCBs exceeded SSVs for 4,4'-DDD, 4,4'-DDE, dieldrin, gamma-BHC, and PCBs. The maximum HQ calculated for pesticides/PCBs was 4.1 for gamma-BHC at location 040MZ106. SVOCs showed HQs above 1 for fluoranthene, 2-methyl naphthalene, naphthalene, and bis(2-ethlyhexyl) phthalate (BEHP). One organic HQ value exceeded 10 (BEHP at sample location 040MZ129).

AZ-2

AZ-2 receives drainage from Site 1 and other sites within its watershed (Figure 2-1), as well as Wetland W2, also known as the southeast drainage ditch. Wetland W2 conveys storm water from the eastern end of Forrest Sherman Field to the southern end of Redoubt Bayou. This wetland also receives surface water from an intersecting ditch that conveys water from the Barrancas Cemetery area and storm water from the NAS Public Works Center (an area that includes IRP Sites 8, 17, and 24 and petroleum site UST 26, see Figure 2-1). Contaminants, primarily 4,4' DDT and PCBs, were elevated in the southern portion of AZ-2 in Redoubt Bayou. HQs for metals in sediment exceeded one for arsenic, cadmium, chromium, copper, lead, mercury, and zinc. HQs for pesticides and PCBs exceeded 1 for 4,4'-DDD, 4,4'-DDE, 4.4'-DDT, dieldrin, gamma-BHC, and PCBs. The maximum HQ value calculated for pesticides/PCBs was 18.5 for 4,4'-DDT at sample location 040MZ224. SVOCs exceeded SSVs for 13 individual constituents, which had HQs below 10.

AZ-3

AZ-3, which receives drainage from Site 1 and the golf course (through Wetlands 3 and 4) as well as other sites within its watershed (Figure 2-1), had the highest SVOC concentrations. Metals in sediment exceeded SSVs for arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc, only one of which one had a HQ above 10 (cadmium at location 040MZ319); most other metals HQs were below 4. Pesticides and PCBs exceeded SSVs for 4,4'-DDE, 4,4'-DDT, dieldrin, gamma-BHC, and PCBs, and only one exceeded a HQ of 10 (dieldrin at location 040MZ322 with a HQ of 138.5). SVOCs exceeded SSVs for 12 individual constituents. Sample location 040MZ324 showed particularly elevated HQ values relative to the SVOCs in other sample locations. The sample was collected near a storm water scupper of the Navy Boulevard Bridge, where the combination of vehicle traffic and storm water would account for the SVOC detections.

Wetland 4D was suspected of impacting the bayou where it drains from the south (Figure 2-1). Data from the Site 41 RI indicate that contaminant levels were higher in the southern portion of Wetland 4D, opposite the side from which it drains into the bayou. Site 41 sediment sample D-3, collected near the Wetland 4D drainage point into Site 40, showed relatively low levels of

contamination compared with the other sediment samples. SSVs in sample D-3 were exceeded for three SVOCs, one pesticide, and no metals, but no HQ values exceeded two. Therefore, Wetland 4D's impact on Bayou Grande is not considered significant.

AZ-4

AZ-4 receives drainage from the Yacht Basin, which in turn receives drainage from many former industrial areas of NAS Pensacola (Figure 2-1). However, HQ values were relatively low, with only two constituents exceeding 10. Within the sediment, metals exceeded SSVs for arsenic, cadmium, chromium, copper, lead, mercury, and zinc. Most other metals HQs were below 3, and none exceeded 10. Pesticides and PCBs exceeded SSVs for 4,4'-DDD, 4,4'-DDT, dieldrin, endrin, gamma-BHC, and PCBs. Only one HQ exceeded 10 (gamma-BHC at the location 040MZ409). SVOCs exceeded SSVs for 12 individual constituents and only one HQ exceeded 10 (acenapthylene at location 040MZ408). These SVOC exceedances may be attributed to the former railroad bridge in this vicinity.

7.1.4 Uncertainties

Uncertainty is inherent in field sampling because field condition, laboratory procedures, or other circumstances may vary. However, every effort was made to reduce uncertainty by using a phased approach. Factors that may result in an over or underestimation of risks (shown as a plus [+] or minus [-] respectively) are listed below.

- Analytical matrix interferences from excess organic material in sediment may have altered the sample results. (+)

- The lack of criteria or screening values for some chemicals increases the uncertainty for screening level assessments. (-)

- The HQ approach does not consider natural metal concentrations, synergistic effects, sediment grain size, or sediment TOC effects as they relate to bioavailability. (-)

- The dynamic nature of a marine ecosystem provides natural variability that is not considered in receptor exposure scenarios. (+ or -)

7.1.5 Phase IIA Contaminant Results and Effect Characteristics

After the contaminants of greatest concern were identified based on SSV exceedances in Phase IIA, sections of the bayou requiring more detailed study were identified along with the parameters of concern. The basis of this additional study was determined in part by the toxicity and interactions of the particular contaminants detected at Site 40. Based on the contaminant results and ecological effects (discussed in Section 10.2.5 of the RI), conclusions were developed based on Phase IIA data. This information was used to develop the conceptual models and determine the most appropriate toxicity tests and bioaccumulation studies for subsequent phases.

The Phase IIA conclusions were as follows:

AZ-1

Certain sediment concentrations of metals, pesticides/PCBs, and SVOCs exceeded SSVs. No IRP sites are associated with this AZ.

AZ-2

AZ-2 had relatively higher HQ values for pesticides and PCBs than the other AZs. These areas were concentrated toward the southern end of AZ-2 in Redoubt Bayou. SVOCs also appeared more prevalent in AZ-2 than AZ-1. Portions of AZ-2 present a potential risk from contaminant bioaccumulation in the food chain as well as from direct toxic SVOC impacts.

AZ-3

AZ-3 showed fewer SSV exceedances for metals and pesticides/PCBs than AZ-1. SVOCs, however, were much more widely distributed with higher HQ values, particularly in location 040MZ324 which was collected near a storm water scupper of the Navy Boulevard Bridge. Vehicle traffic and storm water runoff from the bridge would account for the high SVOC detections, which indicate a potential risk to receptor organisms.

AZ-4

AZ-4 showed fewer SSV exceedances for all contaminant classes than AZ-1, except for elevated SVOC concentrations that indicate a potential excess risk to receptor organisms. As

previously stated, these concentrations are not associated with an IRP site but are suspected to originate from the Navy Boulevard Bridge and the former railroad bridge.

Sample Locations for Phase IIB/III

The Phase IIA sediment data were evaluated to select areas of relative high, medium and low contaminant concentrations. Comparison of effects and impacts with the contaminant gradient yields a better perspective of risk throughout the bayou. The Phase IIA sample locations selected for further study and relative overall contaminant levels are presented in Table 7-1. Primary and secondary contaminants for each Phase IIA sample location are also represented, as well as the subsequent Phase IIB/III sample identification.

7.1.6 Phases IIB and III Approach

The purpose of Phases IIB and III is to relate contaminant levels to specific toxicological or bioaccumulative effects. This section describes why particular Phase IIB/III analyses are considered important in characterizing risk.

Effects and impacts were linked by collecting Phase IIB/III samples from the same locations as the Phase IIA samples (Table 7-1). However, results from the Phase IIB/III chemical data differed from Phase IIA due to factors such as variability in sample placement and natural sediment migration which occurred between sampling events. Toxicological and bioaccumulation data from Phase IIB/III were used to demonstrate or predict direct impacts to assessment endpoint species as well as effects on species at other levels of the food chain. Key assumptions and uses of the Phase IIB/III data are described in this section. Table 7-1 correlates the Phase IIB/III locations with the Phase IIA locations and relative contaminant levels. The 10 sample locations selected for Phase IIB/III are shown in Figure 2-1.

Table 7-1
Phase IIA Sampling Locations Requiring Further Sampling in Phase IIB/III

Assessment Zone	Sample Identification	Phase IIA Results: Relative Overall Contaminant Level	Metals	SVOCs	Pest/PCB	Phase IIB Sample Location Identification*
1	Z1-29	High	Primary	Secondary	NR	4003 or 2B03
1	Z1-30	High	Primary	NR	NR	4003 or 2B03
1	Z1-9	Medium	Primary	NR	PCBs secondary	4002 or 2B02
1	Z1-1, Z1-2, Z1-3	Low	NR	NR	NR	4001 or 2B01
2	Z218 - Z224	High	Primary	Secondary	PCBs secondary	4006 or 2B06
2	Z2-5, Z2-6	Medium	Primary	Secondary	PCBs secondary	4004 or 2B06
2	Z2-28	Medium	NR	NR	NR	4005 or 2B05
3	Z3-4 - Z3-8	High	NR	Primary	NR	4007 or 2B07
4	Z4-19	High	Primary	Primary	NR	4009 or 2B09
4	Z4-8	Medium	Primary	Primary	NR	4008 or 2B08
4	Z4-13 and Z4-14	Low	NR	NR	NR	4010 or 2B10

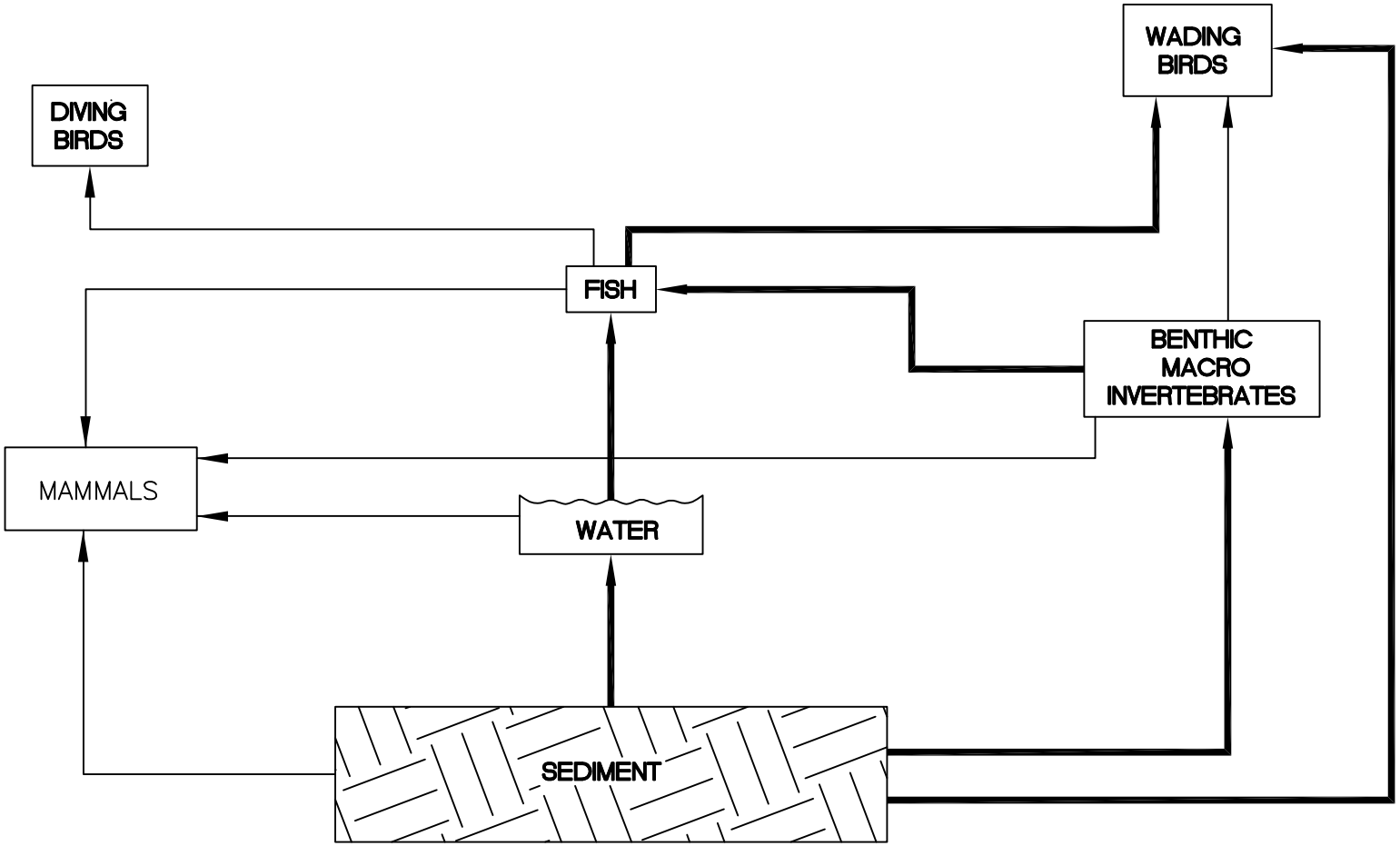
Note:
NR = Phase IIA Sample results did not justify further sampling for these chemicals.

The Site 40 SAP addendum (E/A&H, 1997) describes the technical basis for the following items, which must be addressed in the BRA, and are summarized in this section:

- Conceptual model
- Assessment endpoints
- Measurement endpoints
- Decision points
- Food chain models

Conceptual Model

The conceptual model developed for Site 40 (Figure 7-1) identified exposure pathways and assessment and measurement endpoints used to evaluate potential impacts through those pathways. This model considers the contaminants detected across Site 40, receptors within the estuarine system, and complete pathways expected for contaminant exposure. Impacts on benthic macroinvertebrate populations, fish, and piscivorous (fish-eating) birds were considered most critical. Assessment and measurement endpoints were chosen based on the conceptual model.



NOTE: BOLD LINES INDICATE COMPLETE PATHWAY

NAVFAC Naval Facilities Engineering Command SOUTHERN DIVISION

SITE 40
ROD
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-1
RECEPTOR SPECIFIC
CONCEPTUAL MODEL

DWG DATE: 01/22/04 | NAME: 0083001B002

Assessment Endpoints

Assessment endpoints are the explicit expressions of an environmental value that is to be protected. For the Site 40 investigation, assessment endpoints were selected if (1) sediment contaminants could impact the overall benthic ecosystem and other lower food chain organisms, or (2) primary consumers and organisms higher in the food chain, through direct contact or ingestion, could be exposed to elevated contaminant concentrations in sediment and lower trophic-level food sources.

Assessment endpoints specific to the bayou, representing different levels of the food chain, are the following:

- Protection of the benthic macroinvertebrate community
- Protection and reproductive viability of fish-eating birds
- Protection of nursery habitat for aquatic resources
- Protection of fish viability

These assessment endpoints were chosen because they represent critical components of an estuarine ecosystem and may exhibit contamination effects. Assessment endpoints are further detailed in Table 7-2 and described as follows.

Protection of the Benthic Macroinvertebrate Community: This assessment endpoint is easily measured and may significantly affect higher trophic-level organisms. Benthic macroinvertebrates are an important biomonitoring tools because they are relatively sessile, have long life cycles, and represent a range of ecological niches. In addition to showing acute and chronic toxic effects, benthic organisms also accumulate metals and other contaminants at several orders of magnitude above ambient concentrations in the sediment or surface water. Benthic macroinvertebrates are also localized in their habitat, meaning effects on these organisms can usually be directly related to contamination in that area.

The ability to focus on effects in particular areas may help focus remedial decisions. Impacts on the survival reproduction, and growth of benthos were measured through acute and chronic toxicity tests, population parameters, and tissue concentration studies.

Table 7-2
Assessment and Measurement Endpoints and Decision Points Selected for Site 40
Bayou Grande

Assessment Endpoint	Measurement Endpoint	Decision Point
1. Protection of benthic macroinvertebrate community	1a. Survival, growth, fecundity using *Leptocherius plumulosus* 10-day solid-phase bioassay test	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	1b. Survival, growth, and fecundity using a 20-day *Neanthes arenaceodentata* solid-phase sediment bioassay	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	1c. Survival, growth and fecundity using a 7-day *Mysidopsis bahia* solid-phase sediment bioassay	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	1d. Benthic community indices for qualitative assessment	Investigate potential impacts from physical/chemical variables and compare community indices between stations.
2. Protection of reproductive viability of fish-eating birds	2. Food web model	Unacceptable whole-body tissue concentration which would impair reproduction in assessment endpoint species.
3. Protection of nursery habitat for aquatic resources	3a. Survival, growth, and fecundity using a 20-day *Neanthes arenaceodentata* solid-phase sediment bioassay	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	3b. Acute toxicity using *Leptocheirus plumulosus* 10-day solid-phase bioassay test	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control of similar grain size.
	3c. Survival, growth and fecundity using a 7-day *Mysidopsis bahia* solid-phase sediment bioassay	Statistically significant difference in mortality, growth, or fecundity compared with a laboratory control with similar grain size.
4. Protection of fish viability	4a. Surface water chemistry (TCL organics/TAL inorganics)	Significant exceedances of state/federal chronic water quality standards.
	4b. Food web model	Unacceptable whole-body tissue concentration which would impair reproductive in assessment endpoint species.

Notes:
* = Except for Assessment Endpoint 2 (Protection of reproductive viability of fish-eating birds, which used the great blue heron), the assessment endpoints do not have species-specific representatives.
TCL = Target Compound List
TAL = Target Analyte List

Piscivorous Bird Health and Reproduction: The great blue heron was chosen for several factors relevant to assessing risk in Bayou Grande. The great blue heron is common throughout NAS Pensacola and data are readily available on its habitat use and feeding characteristics. The heron is considered an ideal endpoint species for assessing aquatic food chain contaminant transfer based on its diet, feeding characteristics, and limited home range. For example, the heron feeds on some of the measurement endpoint species chosen. Any impacts on these measurement endpoint species, either through toxicity or body burden effects, may help establish a correlation between effects on the measurement endpoint and effects seen in the heron.

Protection of Nursery Habitat for Aquatic Resources: Bayou Grande is an important nursery habitat for many commercially and recreationally important fish species, as well as a viable breeding ground for other organisms. Younger organisms in a nursery habitat have a limited home range and are exposed to contamination either through diet or direct absorption. The ability to focus on effects in particular areas may help to focus remedial decisions.

Protection of Fish Viability: Fish were chosen as an assessment endpoint species based on potential contaminant exposure through diet and/or absorption. They occupy a significant niche in an estuarine community and effects on populations can alter overall community structure. Body burden and toxicity data from fish species will be important for these reasons:

- Higher Food Chain Impacts — Fish are prey for a variety of other species such as the great blue heron, which is an assessment endpoint species. Fish tissue data may be correlated with impacts on the heron.

- Biotransfer — Fish may ingest sediment during feeding and thus become a direct pathway for transferring contaminants in sediment to other species.

- Toxicity from Direct Exposure — Toxicity to fish species may be correlated with contaminant concentrations in sediment.

Measurement Endpoints

Measurement endpoints provide quantifiable responses to a stressor that can be directly related to the valued characteristic chosen as the assessment endpoint. Measurement endpoints are also described in Table 7-2.

Decision Points

Decision points are defined as toxicological or bioaccumulative effects that indicate ecological risk. A decision point was chosen for each measurement endpoint test analyzed. For all toxicity tests, the decision point is defined as statistically significant differences in mortality, growth, or

fecundity compared with a control. Once these statistically significant differences were established, they were also compared with the reference areas sampled. The decision point chosen for the bioaccumulation analysis was unacceptable whole-body contaminant levels, defined as tissue concentrations that exceed a defined threshold effects level in the assessment endpoint species, in this case the great blue heron. The great blue heron represents a significant level in the food chain and is used in this study to illustrate the potential effects of bioaccumulation in piscivorous birds. Decision points are also listed in Table 7-2.

Food Chain Models

Phase IIA data showed that the upper Redoubt Bayou had significantly higher concentrations of biomagnifying pesticides and PCBs and was thus chosen as the location for forage fish sampling. Fish tissue was analyzed and the data used to model uptake of contaminants by piscivorous birds. Potential fish exposure to dissolved contaminants was also considered.

Contaminants, specifically pesticides and PCBs, were modeled through the food chain to predict impacts to the great blue heron and higher-order fish species as part of the assessment endpoint analysis. SVOCs were not detected in the fish samples, and metals, except for mercury, do not typically bioaccumulate. The technical basis for these models and their formulae are described in Section 7.1.7.4.

7.1.7 Phase IIB/III Sample Results and Interpretation

This section describes each set of sample results across the bayou, how they impact the selected assessment endpoints, and how they are used to assess ecological risk. Risk was characterized using the Sediment Quality Triad, which refers to three sources of data used to quantify risk: 1) chemical data in sediment and surface water, which suggest contaminants that may be driving risk, 2) toxicity and bioaccumulation data, which represent the severity and type of ecological effects predicted in the area sampled, and 3) benthic diversity data, which show actual effects of contamination on sediment-dwelling organisms in a particular area. Each portion of the triad by itself does not yield an accurate estimate of risk in most cases but when viewed together they become an effective means of linking contaminants and effects. The

Sediment Quality Triad is a useful tool for assessing the possible existence and extent of a benthic ecosystem associated with contamination (Chapman et al., 1997). Contamination and effects are summarized in Section 7.1.7.5.

7.1.7.1 Sediment Chemistry

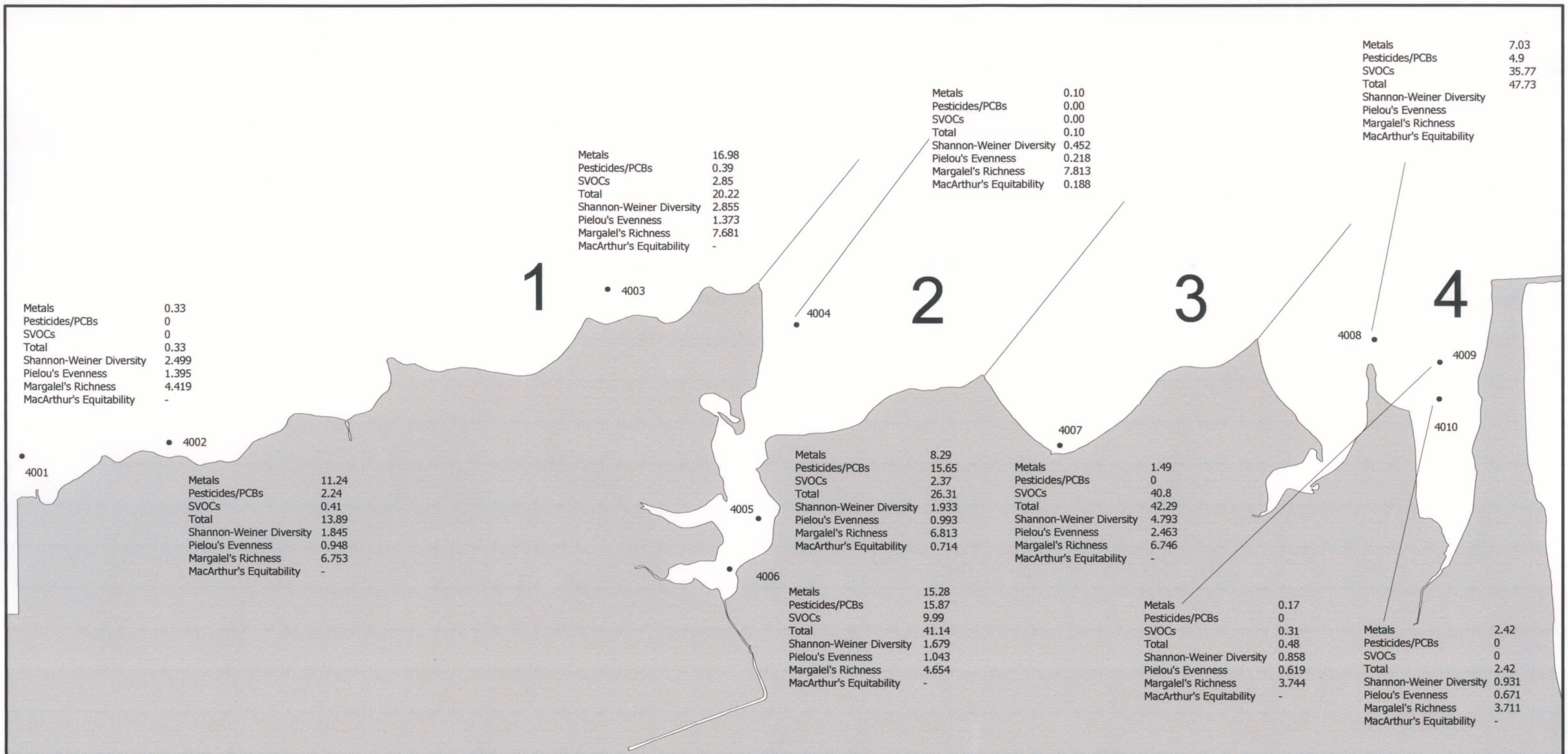
Sediment chemistry, the first portion of the Sediment Quality Triad, impacts all assessment endpoints. Ten sediment samples were collected in Phase IIB/III across the bayou and their sediment chemistry results compared with SSVs (summarized below). Sample locations and HQ values are shown in Figure 7-2 for each contaminant class

Metals

Phase IIB metal concentrations were generally low across the bayou, with AZ-1 (the reference zone), and AZ-2 having the most SSV exceedances. In AZ-1, the maximum HQ was 3.44 for chromium in sample 0301. Arsenic, cadmium, copper, lead, mercury, and zinc also exceeded their SSVs in AZ-1. In AZ-2, the maximum HQ was 4.14 for cadmium in sample 4006. Arsenic, chromium, copper, lead, mercury, and zinc also exceeded their SSVs in AZ-2. In AZ-3, no metals exceeded their SSVs. In AZ-4, two metals exceeded their SSVs in sample 4008 only, with cadmium having an HQ of 1.78 and lead an HQ of 1.25.

SVOCs

Like metals, SVOC concentrations were generally low across the bayou, with two samples, one from AZ-3 and one from AZ-4, showing the most SSV exceedances. In AZ-1, no HQ values exceeded 1. In AZ-2, the maximum HQ calculated was 2.03 for BEHP in sample 4006. Benzo(a)anthracene, benzo(a)pyrene, chrysene, and pyrene also exceeded their SSVs from this sample location. No other SVOC exceeded its SSV in AZ-2. In AZ-3, the maximum HQ calculated was 9.23 for benzo(a)pyrene in sample 4007, which was the only sample collected in this zone. Acenapthene, anthracene, phenanthrene, benzo(a)anthracene, chrysene, fluoranthene, and pyrene also exceeded their SSVs at this sample location. In AZ-4, the maximum HQ calculated was 6.02 for fluoranthene in sample location 4008. Acenapthene, acenapthylene, anthracene, fluorene, phenanthrene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, and pyrene also exceeded their SSVs at this sample location. No other sample location from AZ-4 showed an SSV exceedance.



0 5000 Feet

LEGEND
4001 - SAMPLE LOCATION AND IDENTIFICATION

NAVFAC Naval Facilities Engineering Command

SITE 40
RECORD OF DECISION
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-2
Phase IIB/III Sample
Locations, HI Values, and
Benthic Community Analysis

d:\home4\pensacola_dir-mapping_dir\site_40_revision.apr January 2004

Pesticides/PCBs

Pesticide/PCB concentrations were generally low across the bayou, with the most SSV exceedances in AZ-2. In AZ-1, the only HQ above 1 was in sample location 4001, where lindane's was 1.28. In AZ-2, the maximum HQ calculated was 15.13 for 4,4'-DDT in sample 0501. 4,4'-DDD, 4,4'-DDE, and PCBs also exceeded their SSVs in AZ-2. In AZ-3, no pesticides exceeded SSVs. In AZ-4, two pesticides exceeded their SSVs in sample 4008 only: 4,4'-DDD's HQ was 1.15, and 4,4'-DDE's was 1.06.

7.1.7.2 Surface Water Chemistry

Surface water chemistry results, like the sediment chemistry results, may be applied to the selected assessment endpoints. Surface water samples were collected from three locations during Phase IIB/III: sample 4001 from AZ-1, 4007 from AZ-3, and 4009 from AZ-4. Chemicals detected in surface water were compared to the lower of the state or federal screening criteria, and only two exceedances were noted. In AZ-1, endrin exceeded the USEPA freshwater screening concentration of 0.0023 micrograms per liter (µg/L) (no saltwater screening concentration was available). In AZ-4, copper exceeded its FDEP saltwater screening concentration of 2.9 µg/L. Surface water chemistry results are summarized in Table 7-3, as are each parameter's frequency and range of detection, range of nondetected upper bounds, range of detected concentrations, average detected concentrations, risk-based screening concentration and number of exceedances. Sample locations are shown on Figure 7-2, and complete results are presented in the RI report.

Table 7-3
Screening Comparison for Surface Water Contaminants
NAS Pensacola, Site 40, Phase IIB/III (µg/L)

Parameter	Freq. of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Risk-Based Screening Concentration	Number Over Screen
Pesticides/PCBs						
Endrin	1/3	0.1	**0.0071**	**0.0071**	0.0023 [a]	1
Inorganics						
Aluminum	3/3	NA	73.8 - 194	133.6	1500 [d]	0
Arsenic	1/3	2.2	2.5	2.5	36 [b]	0
Chromium	1/3	0.88	1.4	1.4	103 [b]	0
Copper	3/3	NA	2.1 - **7.8**	**4.1**	2.9 [d]	1
Iron	3/3	NA	34.7 - 230	122.9	300 [d]	0

Table 7-3
Screening Comparison for Surface Water Contaminants
NAS Pensacola, Site 40, Phase IIB/III (µg/L)

Parameter	Freq. of Detection	Range of Nondetected Upper Bounds	Range of Detected Concentrations	Average Detected Concentration	Risk-Based Screening Concentration	Number Over Screen
Selenium	1/3	2.6	3.6	3.6	5 [c]	0
Zinc	1/3	3.7	17.9	17.9	58.9 [c]	0

Notes:

a	=	USEPA screening concentration for freshwater
b	=	FDEP screening concentration for saltwater
c	=	FDEP screening concentration for fresh surface water
d	=	FDEP screening concentration for salt surface water
NA	=	Not applicable, all samples had detections.
µg/L	=	micrograms per liter
BOLD	=	Denotes values exceeding the screening concentration

7.1.7.3 Toxicity Tests

Toxicity tests establish a link between observed contamination and anticipated effects. Bioassay results for Phase IIB/III sediment samples are summarized in Table 7-4, and complete results are presented in the RI report. These tests were performed to gauge impacts on the selected assessment endpoints — protection of the benthic macroinvertebrate community and protection of nursery habitat for aquatic resources. No statistically significant differences in survival, growth or fecundity were at any Site 40 location compared to control sediment samples. Therefore, although SSV exceedances predicted potential adverse effects on benthic invertebrates, toxicity tests did not indicate acute or chronic impacts from contamination.

Acute Toxicity to the Fish Community

Sediment contamination is not expected to impact fish communities. The toxicity tests did not show any statistically significant differences in survival, growth, or fecundity at any Site 40 sample location compared to control samples. Although SSV exceedances predicted potential adverse effects on receptors in certain sample locations, toxicity texts did not indicate acute or chronic impacts from contamination.

Few contaminants were detected in surface water across Site 40 (see Table 7-3). Only one inorganic (copper) and one organic constituent (endrin) exceeded screening values.

Table 7-4
Bioassay Results for Site 40 Sediments, NAS Pensacola, Florida

	Mysid Shrimp *Mysidopsis bahia*			**Amphipod *Leptocherirus plumulosus***			**Annelid Worm *Neanthes arenaceodentata***	
Site	**% Survival**	**Weight (mg)**	**% Fecundity**	**Site**	**% Survival**	**Site**	**% Survival**	**Weight (mg)**
Control	**85**	**0.33**	**93**	**Control**	**97**	**Control**	**100**	**13.5**
4001	90	0.55	100	4001	99	4001	96	9.1
4002	100	0.50	92	4002	93	4002	100	10.0
4003	97.5	0.64	100	4003	98	4003	100	9.1
4004	97.5	0.55	100	4004	95	4004	100	13.1
4005	97.5	0.68	100	4005	95	4005	100	14.5
Control	**82.5**	**0.37**	**80**	4006	95	**Control**	**100**	**9.9**
4006	82.5	0.57	100	**Control**	**100**	4006	100	10.6
4007	100	0.60	100	4007	93	4007	100	12.5
4008	97.5	0.61	92	4008	98	4008	100	11.6
4009	95	0.65	100	4009	95	4009	100	10.3
4010	97.5	0.60	100	4010	96	4010	100	9.5

Notes:
mg = milligrams
No results were statistically different from the control set ($\alpha = 0.05$).

Copper was detected at all three sampling locations, exceeding the state and federal criteria at location 4007 only. Endrin's only detection, 0.0071 µg/L, was above the criterion set for fish marketability; no true ecological standard was available. Because of the relatively low levels of surface water contamination, waterborne contaminants at Site 40 are not expected to impact fish communities.

7.1.7.4 Bioaccumulation Studies

In the Sediment Quality Triad, bioaccumulation studies are used to evaluate potential toxic effects. However, these tests serve to predict toxicity to the selected assessment endpoints rather than demonstrate actual toxicity. Site 40 bioaccumulation studies were performed to quantify impacts on the reproductive viability of fish-eating birds and the viability of fish based on the level of contaminants detected in foraging fish tissue.

Great Blue Heron Food Chain Model

A food chain model for the great blue heron, a piscivorous bird, was developed to estimate its dietary exposure to Site 40 contaminants based exclusively on ingestion of contaminated fish. The *Wildlife Exposures Factors Handbook* (USEPA, 1993) states that small foraging fish comprise a significant portion of the heron's diet. More information about this model is presented in the RI report.

Bioaccumulation impacts to the great blue heron were evaluated based on the chemical contamination found in foraging fish tissue. At location 4006, two species were collected for tissue studies: *Fundulus grandis* (killifish) and *Lagodon rhomboides* (pinfish). Based on information in the USEPA's *Wildlife Handbook*, killifish and pinfish are common prey species for the great blue heron. Four specimens of killifish were collected as composite whole-fish sample 40-06-1, with lengths ranging from 90 to 122 millimeters (mm). Nine specimens of pinfish were collected as composite whole-fish sample 040-06-2, with lengths ranging from 55 to 75 mm. Total contaminant concentrations detected in each sample are shown in Table 7-5. All HQs for the heron were calculated from oral ingestion of total 4,4'-DDT and total PCBs in fish tissue according to the model described in Section 7.1.7. Results are shown in Table 7-5. All HQs were below 1, indicating no risk to the great blue heron from ingestion of fish tissue.

Table 7-5
Pesticide/PCB Exposure Estimates and Hazard Prediction for Blue Heron at Site 40
NAS Pensacola, Florida

Location	Parameter	Tissue Conc.[1] (mg/kg)	Sediment Conc.[2] (mg/kg)	Water Conc.[3] (µg/L)	PDE[4]	NOAEL[5]	LOAEL	HQ[6]
40-06-1	total DDT	0.015	ND	ND	0.0027	0.003	0.028	0.7
40-06-2	total DDT	0.014	ND	ND	0.0025	N/A	N/A	0.6
40-06-1	total PCB	0.090	0.065	ND	0.016	0.18	1.8	0.08
40-06-2	total PCB	0.100	0.065	ND	0.018	N/A	N/A	0.10

Notes:
1 = Whole-body killifish or pinfish (wet weight) found in Appendix C, matrix ID "J."
2 = Samples from top 5 cm of sediment (wet weight) found in Appendix C, matrix ID "M."
3 = Detected concentration or one-half detection limit
4 = Potential Dietary Exposure: from great blue heron model in Section 10.2.7.
5 = Effects Levels in Sample et al., 1996; referenced from Dahlgren et al., 1972, and Anderson et al., 1975
6 = lowest Observed Adverse Effects Level
7 = Hazard Quotient = PDE/NOAEL
ND = Not detected
mg/kg = milligrams per kilogram
µg/L = micrograms per liter

Fish Exposure Model

The fish exposure model described below was used to predict contaminant effects on higher trophic-level fish species based on contaminants detected in the whole-body tissue of foraging level fish because higher trophic level fish feed on prey fish. In evaluating these effects, food chain interactions are considered the most significant exposure route because most level 4 fish species are not typically exposed to sediment, and Site 40 surface water samples did not show significant concentrations of pesticides. Of the three surface water samples collected from Site 40 during Phase IIB, only delta-BHC and endrin were detected at 0.0031 and 0.0071 µg/L, respectively. Neither of these compounds were detected in Site 40 fish tissue samples. The model excludes exposure to metals since most metals, with the exception of mercury, do not typically biomagnify. Results of the fish exposure model are presented in Table 7-6 and further explained in the RI report.

Red Drum Mercury Bioaccumulation Model

This model was initially introduced in the Site 40 Final RI Report Addendum and was used to predict mercury tissue concentrations in predatory fish based on concentrations in the sediment at Site 40. The model assumes that mercury uptake in the red drum occurs via prey ingestion exclusively. In order to reduce the uncertainty associated with the model, subsequent sampling was performed in 2001 to collect sediment and whole fish-tissue samples for mercury analysis. Both sediment and whole fish-tissue mercury results were then used to estimate predatory fish mercury concentrations. The sediment mercury results were modeled to estimate the methyl mercury tissue concentration in predatory fish, while the prey fish tissue mercury results provided an exact measurement for use in the model.

Table 7-6
Predicted Upper Trophic Level Fish Tissue Concentrations from Maximum Prey Fish Concentrations

Constituent	Maximum Prey Fish Tissue Conc (µg/kg)	Prey Fish Tissue Conc (mg/kg)	TTC	Predicted Upper Trophic Level Fish Tissue Concentration (mg/kg)	No Observed Adverse Effects Level (mg/kg)	HQ
4,4'-DDE	12.00	0.012	10	0.12	0.10	1.2
4,4' – DDD	3.80	0.0038	10	0.038	0.10	0.38
Chlordane	1.70	0.0017	10	0.017	0.01[2]	1.70
Arochlor-1260	100.00	0.100	7	0.7	0.10[3]	7.00
Lindane	0.74	0.00074	10	0.0074	0.537[4]	0.01

Table 7-6
Predicted Upper Trophic Level Fish Tissue Concentrations from Maximum Prey Fish Concentrations

Constituent	Maximum Prey Fish Tissue Conc (µg/kg)	Prey Fish Tissue Conc (mg/kg)	TTC	Predicted Upper Trophic Level Fish Tissue Concentration (mg/kg)	No Observed Adverse Effects Level (mg/kg)	HQ
Dieldrin	1.30	0.0013	10	0.013	1.00[5]	0.013
Aldrin	0.66	0.00066	10	0.0066	0.10[6]	0.066
					Total	10.37

Notes:
1 = 0.10 mg/kg (NOAEL) for mortality in the spiny dogfish, from Guarino, A.M. and S.T. Arnold
2 = 0.01mg/kg (NOAEL) for mortality in the spot, from Schimmel, S.C., J.M. Patrick, .and J. Forester
3 = 0.10 mg/kg (LOAEL) for physiological effects in the common carp, from Melancon, M.J. and J.J. Lech
4 = 0.537 mg/kg (NOAEL) for mortality in the fathead minnow from Macek, K.J., K.S. Buxton, S.K. Derr, J.W. Dean and S. Sauter
5 = 1.0 mg/kg (NOAEL) for mortality in the spiny dogfish from Guarino, A.M. and S.T. Arnold
6 = 0.10 mg/kg (LOAEL) for morphological effects in the Atlantic Salmon from Addison, R.F., M.E. Zinck and J.R. Leahy
TTC = Tropic Transfer Coefficient (Suedel et al., 1994)
NOAEL = No observed adverse effect level
LOAEL = Lowest observed adverse effect level

The modeled results were compared to the USEPA NOAEL of 0.15 ppm and the LOAEL of 0.30 ppm.

Results of the red drum model are presented in Tables 7-7 and 7-8. As can be seen from the data, the red drum model predicts a much lower risk for Site 40 using actual forage-fish tissue mercury data in place of estimated fish tissue data. The modeling of the 2001 sediment and fish tissue mercury data substantiate the overall reduction in mercury concentrations in Bayou Grande since 1996, and the decreased risk predicted for predatory fish at Site 40.

Risk Characterization

It appears that there is a potential risk to upper trophic level fish species from dietary exposure to PCBs, chlordane, 4,4'-DDE and mercury in prey fish species because each of these compounds yielded an HQ value above 1. Based on the information from Suedel et al. (1994), these effects could include mortality or physiological changes.

Although there is a potential risk to level 4 fish species, several uncertainties are inherent in the models used. First, Trophic Transfer Coefficient (TTC) values used in the fish exposure model were derived from a literature review and not site-specific data. Second, toxic effects values for this model were derived from fish species not indigenous to the PBS and which were exposed to the contaminants through means other than tissue ingestion.

Table 7-7
Mercury in Upper Trophic Level Fish
Red Drum Mercury Model — Mercury in Forage Fish Estimated

Sample Location	Hg in Sediment (ppm)	Hg in Forage Fish[b] (ppm)	Hg in Crustaceans (ppm)	Hg in Invertebrates (ppm)	Hg in Red Drum Tissue (ppm)	NOAEL HQ	LOAEL HQ
1996 Results							
040MZ130	2.2	2.64	0.616	0.22	5.653	37.69	18.8
040MZ216	0.03[a]	0.036	0.008	0.003	0.077	0.51	0.26
040MZ237	0.08	0.096	0.022	0.008	0.206	1.37	0.69
040MZ244	0.64	0.768	0.179	0.064	1.645	10.96	5.48
040MZ247	0.28	0.336	0.078	0.026	0.720	4.8	2.4
040MZ316	0.14	0.168	0.039	0.014	0.360	2.4	1.2
040MZ401	0.155[a]	0.186	0.043	0.016	0.398	2.66	8.85
2001 Results							
040MZ130	0.0025[a]	0.003	0.001	0.0003	0.006	0.04	0.02
040MZ216	0.24	0.288	0.067	0.024	0.617	4.11	2.06
040MZ237	0.01	0.012	0.001	0.001	0.026	0.17	0.09
040MZ244	0.0031[a]	0.004	0.0009	0.0003	0.008	0.05	0.03
040MZ247	0.26	0.312	0.073	0.026	0.668	4.45	2.23
040MZ316	0.0027[a]	0.0032	0.00076	0.00027	0.0069	0.05	0.02
040MZ401	0.0028[a]	0.0034	0.00078	0.00028	0.0072	0.05	0.024
040NZ237 (offsite location)	0.011	0.0132	0.00308	0.0011	0.02827	0.189	0.095

Notes:
a = Results were non-detect; number reflects one half detection limit
b = Results derived by estimating the mercury concentration in forage fish using the appropriate calculation from the Red Drum Mercury Model.
HQ = Hazard Quotient
NOAEL = No Observable Adverse Effects Level of 0.15 ppm (NOAA, 2001)
LOAEL = Lowest Observable Adverse Effects Level of 0.30 ppm (NOAA, 2001)
ppm = parts per million

Table 7-8
Mercury in Upper Trophic Level Fish
Red Drum Mercury Model — Mercury in Forage Fish Measured

Sample Location	Hg in Sediment (ppm)	Hg in Forage Fish[c] (ppm)	Hg in Crustaceans (ppm)	Hg in Invertebrates (ppm)	Hg in Red Drum Tissue (ppm)	NOAEL HQ	LOAEL HQ
040MZ130	0.0025[b]	0.042	0.001	0.0003	0.062	0.42	0.21
040MZ216	0.24	0.033	0.0672	0.024	0.251	1.66	0.84
040MZ237	0.01	0.06	0.003	0.001	0.095	0.63	0.32
040MZ244	0.0031[b]	0.01[a]	0.001	0.0003	0.017	0.11	0.06
040MZ247	0.26	0.026	0.073	0.026	0.258	1.72	0.86
040MZ316	0.0027[b]	0.052	0.0008	0.0003	0.077	0.51	0.26
040MZ401[a]	0. 0028[b]	0.003	0.0008	0.0003	0.007	0.05	0.02
040NZ237 (offsite location)	0.011	0.032	0.0031	0.0011	0.468	3.342	1.56

Notes:
a = No forage fish were collected at location 040MZ401. The estimated value of mercury in forage fish from Table 4 for this location is substituted for comparison.
b = Results were non-detect; number reflects one half the detection limit
c = Results derived from whole fish tissue analysis
HQ = Hazard Quotient
NOAEL = No observable Adverse Effects Level of 0.15 ppm (NOAA, 2001)
LOAEL = Lowest observable Adverse Effects Level of 0.30 ppm (NOAA, 2001)
ppm = parts per million

In addition, the possible sources and distribution of PCBs, chlordane, 4,4'-DDE, and mercury in the PBS should be considered. Pesticides and PCBs are widely distributed in the environment from numerous sources via both land and airborne migration. 4,4'-DDT was not detected in the fish samples suggesting that the detected concentrations of its daughter products are from residual contamination of this banned substance. Although mercury was detected in sediment and fish-tissue, a historical environmental document review indicates that mercury cannot be attributed to any IRP site at NAS Pensacola. Therefore, it is most likely that the concentrations in predatory fish at Site 40 were the result of ubiquitous distribution of these residual contaminants in the PBS, and not point-source impacts from NAS Pensacola.

7.1.7.5 Benthic Community Analysis

Benthic community analysis is the final link in the Sediment Quality Triad. These data show what effects are actually occurring in the area sampled, possibly due to site contamination. Species diversity results alone are not considered as reliable an indicator of ecological risk due to the many influencing factors such as sediment type, sediment deposition rates, water temperature, salinity, waterborne nitrates and phosphates, dissolved oxygen, and a host of other factors not directly related to site contaminants. Therefore, it is important to view species diversity in context with contaminant concentrations and toxicity test results. Four tests (Shannon-Weiner, Pielou's Evenness, Margalef's Richness Diversity, and MacArthur's Equitability) were performed in Bayou Grande, and the results are described below. Results of these four tests are shown on Figure 7-2 and are summarized in Table 7-9.

- The Shannon-Weiner Index is an index of species diversity. For example, a low diversity as shown in sample 40-04 indicates that one species is predominant in a location. Specifically in sample 40-04, the low diversity was the result of a high number of *Polymesoda* (freshwater clams) indicates that the field sampling crew hit a "pocket" of these bivalves.

Table 7-9
Number of Benthic Organisms Identified at Site 40 Sample Locations

			AZ-1				AZ-2		AZ-3	AZ-4		
TAXON	**Family**	**Species**	**40-01**	**40-02**	**40-03**	**40-04**	**40-05**	**40-06**	**40-07**	**40-09**	**40-10**	**Sum**
Nemertea	Unid.	LPIL		1	4		8	1	4	1		19
Echiurida	Echiuridae	LPIL							1			1
Gastropoda	Hydrobiidae	Onobops sp.	1									1
Gastropoda	Littorinidae	Littorina irrorata									4	4
Gastropoda	Melampidae	Detracia floridana							1			1
Gastropoda	Melampidae	Melampus sp.			1						1	2
Gastropoda	Planorbidae	LPIL				1						1
Pelecypoda	Corbiculidae	Polymesoda sp.	2			200			12	41		255
Pelecypoda	Mytilidae	Amygdalum papyrium		3	2			1				6
Pelecypoda	Solecurtidae	Tagelus plebius								1		1
Polychaetae	Ampharetidae	Hobsonia florida	2									2
Polychaetae	Capitellidae	Capitella capitata	1	34	2	2	69	5				113
Polychaetae	Capitellidae	Mediomastus californiensus		5	4		54		3		1	67
Polychaetae	Goniadidae	Glycinde solitaria							1			1
Polychaetae	Nereidae	Neanthes sp.		3	3		2					8
Polychaetae	Orbiniidae	Scolopus fragillis			5	5	2					12
Polychaetae	Paronidae	Aricidae sp.								7		7
Polychaetae	Pilargiidae	Parandalia americana				1						1
Polychaetae	Sabellidae	Chone cf. Americana				1						1
Polychaetae	Spionidae	Paraprionospio pinnata		1								1
Polychaetae	Spioidae	Polydora sp.										
Polychaetae	Spionidae	Streblospio benedicti		10	2		73	10	29		26	150
Cladocea	Unid.	LPIL					2					2
Isopoda	Anthuridae	Cyathura polita	1			1						2
Cumacea	Nannasticidae	Almyracuma sp.						1				1
Decapoda	Unid. Larvae	LPIL				1						1
Coleoptera	Chelonariidae	Chelonarum sp.	1									1
Total Individuals			8	57	23	212	210	18	51	50	32	661
Number of Species			6	7	8	8	7	5	7	4	4	28
Shannon-Weiner Diversity			2.499	1.845	2.855	0.452	1.933	1.679	4.793	0.858	0.931	2.770
Pielou's Evenness, J'			1.395	0.948	1.373	0.218	0.993	1.043	2.463	0.619	0.671	0.831
Margalef's Richness, D			4.419	6.753	7.681	7.813	6.813	4.654	6.746	3.744	3.711	27.848
MacArthur's Equitability Index			—	—	—	0.188	0.714	—	—	—	—	0.339

Note:
No benthic sample was collected at Station 08, due to an error in sampling procedure.

- Pielou's Evenness Index may be used as an additional tool for measuring the quality of the environment. Generally, a value of 1 (or close to 1) is considered healthy and indicating an even distribution of abundance and number of species (e.g., in sample A 8 species were present and 10 samples of each species are present; therefore, the index value is 1.0).

- Margalef's Richness Diversity includes both components of species diversity: richness of species and distribution of individuals among the species. This index emphasizes the distribution of individuals among species, which can readily be extracted from the overall data sets. The index reflects of the number of sample grabs per site from which the data are combined and estimates the occurrence of the expected number of species per 1,000 organisms.

- The MacArthur Equitability Index results in a distribution often observed in nature, several relatively abundant species and increasing numbers of species represented by only a few individuals. MacArthur's Equitability estimates distribution based on the sampling stations, but there were not enough stations in these data sets to adequately use this method.

Generally, polychaetes dominated the benthic community across the site. For all stations combined, three "pollution tolerant" polychaete species (Olinger et al., 1975; Reish, 1960; and Gilet, 1960) — *Capitella capitata, Mediomastus californiensus*, and *Streblospio benedicti* — comprised approximately half of the individuals identified (see Table 7-9).

The occurrence of representatives from the *Echiuridae* (spoon worms), *Sabellidae* (annelid worms), and *Nannasticidae* (worm) families, sites 40-07, 40-04, and 40-06, respectively, are good indicators of a healthy benthic environment.

7.1.8 Risk Characterization by AZ

The above data are tabulated by AZ to correlate contaminant levels with effects using the Sediment Quality Triad approach. Contaminant concentrations in sediment are determined by evaluating the maximum HQ value for each contaminant class. As there were no toxic effects relative to laboratory controls, all values for these samples will consistently show no observed contaminant effects. Species diversity is compared with the different diversity indices calculated. Predicted impacts to higher trophic-level fish species from bioaccumulating pesticides or PCBs are also considered using the fish and heron models. As there were no effects predicted from contaminant bioaccumulation, all values for these parameters will consistently show no predicted effects on higher level fish species or the heron.

AZ-1

Toxicity was not shown for any of the organisms chosen in the toxicity tests. The Pielou's Evenness Index for each sample location also indicated that the area is healthy and the abundance and number of species are evenly distributed. Since foraging fish samples were not collected in this AZ, no impacts were calculated for higher order fish species or the heron. The data are shown on Table 7-10.

AZ-2

Because AZ-2, particularly the southern portion, showed the highest 4,4'-DDT sediment concentration of the four AZs, it was chosen for analyzing fish tissue for contaminant bioaccumulation and predicting impacts on higher level fish species and the great blue heron. Phase IIB/III sample 4006 was chosen for this analysis because this area's Phase IIA analytical results (AZ-2 locations 18 through 24) had the highest HQ (33). Impacts are not predicted for either of these species, and toxicity was not shown for any organisms analyzed in the three sample locations. A relatively large number of SSV exceedances for metals and SVOCs were present in samples 4004, 4005, and 4006. Except for sample 4004, Pielou's Evenness Index for each sample location is near 1, indicating that the area is healthy and the abundance and number of species are evenly distributed. 4004 and 4006 also had representatives from the *Sabellidae* (annelid worms) and *Nannasticidae* (worm) families, which are indicators of a healthy environment. The data are shown on Table 7-10.

Table 7-10
Phase IIB/III
Sediment Quality Triad Analysis

Sample Location	Maximum HQ Metals	Maximum HQ Pesticides/PCBs	Maximum HQ SVOCs	Toxicity Above Control?	Shannon Weiner Diversity	Pielou's Evenness	Margalef's Richness	MacArthur's Equitability	Predicted Higher Order Fish Impact?	Predicted Heron Impact?
ASSESSMENT ZONE 1										
4001	0.09	NA	NA	No	2.499	1.395	4.419	—	NA	NA
4002	2.22	1.28	0.25	No	1.845	0.948	6.753	—	NA	NA
4003	3.44	0.39	0.72	No	2.855	1.373	7.681	—	NA	NA
ASSESSMENT ZONE 2										
4004	0.04	NA	NA	No	0.452	0.218	7.813	0.188	NA	NA
4005	1.63	15.13	0.58	No	1.933	0.993	6.813	0.714	NA	NA
4006	4.14	6.47	1.76	No	1.679	1.043	4.654	—	Yes	No
ASSESSMENT ZONE 3										
4007	0.56	NA	9.23	No	4.793	2.463	6.746	—	NA	NA
ASSESSMENT ZONE 4										
4008	1.78	1.81	6.02	No	NA	NA	NA	NA	NA	NA
4009	0.06	NA	0.12	No	0.858	0.619	3.744	NA	NA	NA
4010	0.86	NA	NA	No	0.931	0.671	3.711	NA	No	No

Notes:
No benthic community samples were collected at locations 8 due to an error in the sampling process.
NA = Not Applicable

AZ-3

Except for SVOCs, AZ-3 showed lower numbers and concentrations of contaminants than AZ-1. SVOCs showed particularly elevated HQ values for sample location 4007. Toxicity was not shown for any of the organisms analyzed in sample4007 in AZ-3. Data are shown on Table 7-8. The occurrence of the representative from the *Echiuridea* family (spoon worm) indicates a healthy environment (Table 7-9).

AZ-4

Except for SVOCs, AZ-4 showed comparable or lower numbers and concentrations of contaminants than AZ-1. Toxicity was not shown for any organisms analyzed in the three sample locations. The data are shown on Table 7-10.

7.1.9 Ecological Risk Summary and Conclusion

The screening-level risk assessment (Phase IIA) indicated a potential risk to ecological receptors in Bayou Grande. However, results of the Sediment Quality Triad performed during Phase IIB/III do not support additional action. Toxicity tests showed no effects to benthic species from exposure to Site 40 sediments. Although perturbations were observed in benthic community populations between stations, no effects were predicted or shown from the other two components of the Sediment Quality Triad. It is therefore difficult to account for the differences in species diversity, but natural variability or physicochemical effects may be the cause. The occurrences of spoon worms, fan worms, and nannasticidea at 4004, 4006, and 4007 are indicators of a healthy environment, as are the fresh- water clams (*polymedsoda*) at 4004. Furthermore, contaminant concentrations in surface water did not indicate acute or chronic impacts to fish.

Tissue concentrations from the composite fish samples were not at levels predicted to pose a risk to fish-eating birds, but the model did predict a risk to upper trophic-level fish. One contributor to the excess risk was 4,4'-DDE. All Site 40 4,4'-DDE concentrations were detected below its background concentration of 40 parts per billion (ppb) indicating 4,4'-DDE's widespread occurrence in the PBS.

Since measurement endpoints are not impacted, impacts to the assessment endpoints are are not indicated. Therefore, no ecological risk is predicted within Bayou Grande, and no action is recommended.

7.1.10 Uncertainty

General uncertainties are inherent in ecological risk assessments. Table 7-11 shows the types of uncertainties that could impact final risk calculations. A plus (+) or minus (-) is associated with each uncertainty to provide a quantitative perspective. A plus suggests that the uncertainty has most likely resulted in an overestimation of risk, and a minus suggests an underestimation. Both signs together indicate that the uncertainty could cause either under or overestimation of risk.

Table 7-11
Uncertainties Associated with the Ecological Risk Assessment at Site 40, Bayou Grande

Uncertainty Issue	Effect on ERA
Sampling fish from a limited area of Bayou Grande	-
Variables in chemical contamination between Phases IIA and IIB	+ or -
Chemical degradation for selected ECPCs	+
Specific effects on biota within study area	+ or -
Effects data not available for some ECPCs	-
Synergistic or antagonistic effect of ECPCs	+ or -
Assumption for effects from similar compounds	+ or -
Use of related species for risk to selected receptor species	-
Dermal or inhalation pathways not evaluated	-
Maximum concentrations were used in the exposure model	+
Unknown frequency of wildlife species within contaminated area	+
Use of literature-generated ingestion rates	+ or -
Use of sediment screening values derived from laboratory studies	+
Exposure assumed to be 100%	+
Regional sediment characteristics not accounted for	+
Actual bioavailability not measured (assumed to be 100%)	+
Metal-specific effects not accounted for in benthic assessment	-
Use of NOAEL as basis of risk determination for birds	+
The most bioavailable form of a chemical was used in the screening assessment	+
Use of SQAG-TELs as a basis of risk determination for benthos	+
Level 4 fish feed in many different areas	+
TTC values for organochlorine compounds are based on field data	+

Table 7-11
Uncertainties Associated with the Ecological Risk Assessment at Site 40, Bayou Grande

Uncertainty Issue	Effect on ERA
Toxic residue effects levels from the US Army COE database may not apply to species in the Pensacola Bay System.	+ or -
NOAEL values may actually be higher and LOAEL values may actually be lower than those cited in the COE database.	+ or -

Notes:
COE = Army Corp of Engineers
ERA = Ecological Risk Assessment
ECPC = Ecological Chemical of Potential Concern
LOAEL = Lowest observed adverse effect level
NOAEL = No observed adverse effect level
\+ = May result in overestimate of risk.
\- = May result in underestimate of risk.
\+ or - = May result in either an over or underestimation of risk.

7.2 Human Health Risk Assessment

This assessment examines the potential for human exposure to the contaminants detected in surface water and sediment at Site 40. Surface water sampling was limited in Bayou Grande because results would only provide a "snapshot in time" and only validate general surface water quality conclusions. Surface water data were evaluated in terms of risk to human health, although surface water conditions in Bayou Grande reflect contributions from natural background, and other anthropogenic sources, as well as potential transport from NAS Pensacola. Sediments on shore were not sampled because they do not represent an environment conducive to deposition. These sediments are winnowed regularly by wind and water resulting in a well-sorted fine to medium- grain quartz sand. These sands are chemically inert, offering negligible exposure because of the grain size. However, surface soil samples were collected at the IRP sites along Bayou Grande including Sites 1, 15, 11 (part of OU 2), 13 (part of the OU 10 RI) report and OU 10 (Sites 32, 33, and 35). The ecological and human health risk assessments were performed for each of these sites, and are presented in their respective RI reports. For these reasons, only submerged sediments were sampled at Site 40. Exposure to contaminants in sediment was considered insignificant since these sediments are continuously submerged. However, unfiltered surface water contains suspended sediments and was evaluated for human health risk via dermal contact and incidental ingestion. Incidental ingestion of surface water and ingestion of fish, shellfish, and crabs were considered the most likely exposure pathways in terms of human health risk. Surface water samples were collected from Assessment Zones 1, 3, and 4, and prey fish samples were collected from AZ-2.

7.2.1 Exposure Scenarios

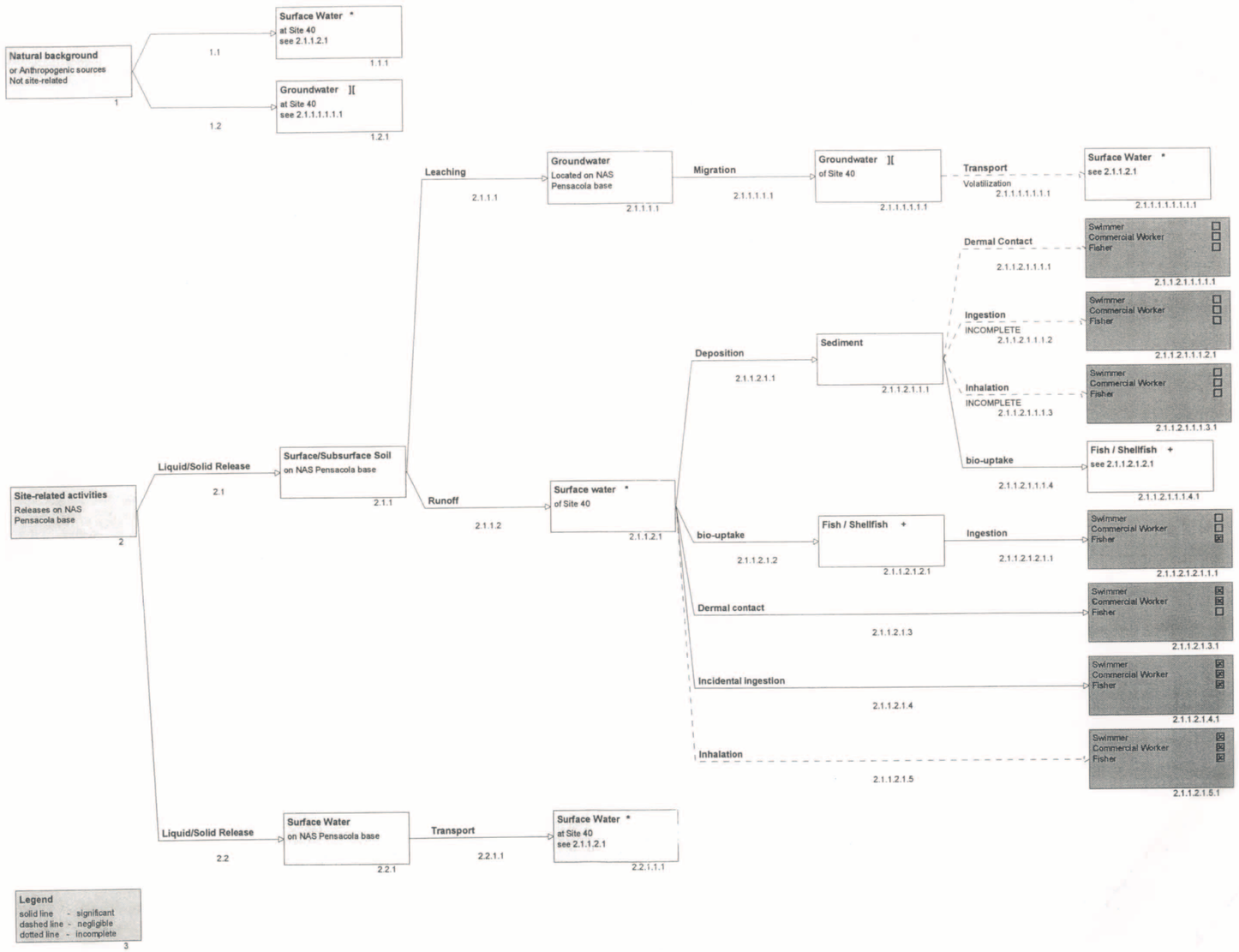
The potential transport and exposure pathways are shown in the stem-and-leaf type conceptual site model (Figure 7-3). Potential human receptors include a recreational swimmer, a recreational fisherman, a subsistence fisherman, and a commercial worker (e.g., a lifeguard). The fishermen and commercial workers' scenarios were considered to conservatively represent any potential site worker exposures. Brief explanations of the selected model components are provided as follows:

- ***Fish ingestion***. The recreational and subsistence fisherman receptors were assumed to be exposed to contaminants reported in the bayou through consumption of contaminated fish and shellfish.

Vapor inhalation. Since the open nature of the site will not likely allow for appreciable air buildup of VOCs, the vapor inhalation exposure pathway is considered a *potential but insignificant pathway*. Additionally, only one VOC was reported in surface water at a low concentration.

- ***Dermal contact***. Dermal contact with deposited sediment is considered a *potential but insignificant pathway* at Site 40. Human exposure to contaminants reported in sediment is limited due to the overlying surface water and reduced adsorption of sediment to skin (submerged sediments tend to wash off). Dermal contact with suspended or dissolved solids and sediments is considered in the evaluation of dermal contact with whole surface water samples (surface water samples were not filtered prior to analysis).

- ***Incidental ingestion***. The recreational swimmer, fishermen, and commercial worker may involuntarily ingest small amounts of surface water. The swimmer and the commercial worker may directly swallow small amounts of surface water while swimming, whereas the fishermen may incidentally ingest splashed or sprayed surface water.



NAVFAC Naval Facilities Engineering Command SOUTHERN DIVISION

SITE 40
ROD
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 7-3
POTENTIAL TRANSPORT AND EXPOSURE PATHWAYS FOR HUMAN HEALTH RISK ASSESSMENT

DWG DATE: 01/23/04 | NAME: 0083001B003

Swimming is allowed at Site 40 at the Family Picnic Area near Site 1 and at the Sailing Facility. Off base, across the bayou to the north, private landowners swim, fish, and crab without limitations of base regulations. However, public access to the bayou is limited to boating. Some areas of Bayou Grande along the base are not posted as "no swimming areas," and swimming in these areas is assumed to be limited by the difficulty of site access. No swimming is allowed along the NAS Pensacola golf course shoreline, and this is enforced by Navy security. Public boating and skiing are common activities in the bayou. However, the activities are restricted to areas outside of Homeland Security restrictions.

To evaluate the significance of contaminant concentrations reported in surface water samples, data were compared to Federal Ambient Water Quality Criteria (AWQC) and surface water preliminary remediation goals (PRGs). Federal AWQCs are from 40 CFR 131.36 and are human-health based. It was assumed that the bayou was not a primary drinking water source due to its salinity; concentrations based on the consumption of organisms were used only for screening purposes in this risk assessment. Surface water PRGs were calculated for adolescent recreational swimmers and adult commercial workers (e.g., lifeguards). Receptor populations were selected based on swimming activities observed in the bayou. These receptor populations are reasonably representative of other recreational activities such as water skiing and fishing (regarding the fishermens' direct contact with surface water; indirect contact through fish ingestion is addressed separately). It is assumed that both the adolescent recreational swimmer and the commercial worker are exposed to contaminants (dissolved and suspended) through incidental ingestion of and dermal contact with surface water. The equations and associated parameters used to calculate these PRGs are presented below; calculated PRGs are presented in Table 7-12.

Table 7-12
Preliminary Remediaton Goals for Surface Water
NAS Pensacola, Site 40, Bayou Grande — Pensacola, Florida

						Recreational Swimmer PRGs		Commercial Worker PRGs	
	Oral RfD (mg/kg-day)	Oral SF (kg-day/mg)	ADJ (-)	ABS (-)	Kp (cm/hr)	Hazard Based (mg/L)	Risk-Based (mg/L)	Hazard Based (mg/L)	Risk-Based (mg/L)
Aluminum	1	NA	0.2	0.001	0.001	7462	NA	11355	NA
Arsenic	0.0003	1.5	0.2	0.001	0.001	2.2	0.035	3.4	0.021
Barium	0.07	NA	0.2	0.001	0.001	522	NA	795	NA
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	0.005	NA	0.2	0.001	0.001	37	NA	57	NA
Copper	0.04	NA	0.2	0.001	0.001	298	NA	454	NA
Delta-BHC	NA	1.8	0.5	0.01	0.0031	NA	0.028	NA	0.017
Endrin	0.003	NA	0.5	0.01	0.016	2.2	NA	3.3	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	0.02	NA	0.2	0.001	0.001	149	NA	227	NA
Potassium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	0.005	NA	0.2	0.001	0.001	37	NA	57	NA
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	0.2	NA	0.8	0.01	0.045	1342	NA	1948	NA
Vanadium	0.007	NA	0.2	0.001	0.001	52	NA	79	NA
Zinc	0.3	NA	0.2	0.001	0.001	2239	NA	3406	NA

Exposure Parameters	
THQ	1
TR	1E-06
IR	0.05 L/hr
SA — adoles	1.56 m2/hr
SA — adult	2.3 m2/hr
ET	1 hr/day
EF	45 days/yr
EF — adoles	10 yrs
ED — adult	25 yrs
CF	10 L/cm*m2
BW — adoles	46 kg
BW — adult	70 kg
ATnc — adoles	3650 days
ATnc — adult	9125 days
ATc	25550 days

Adolescent Recreational Swimmer and Occupational Adult — Noncancer

$$PRG = \frac{THQ * BW * ATnc}{ET * EF * ED\left[\left(SA * Kp * ABS * CF/RfD * ADJ\right) + \left(IR/RfD\right)\right]}$$

Adolescent Recreational Swimmer and Occupational Adult — Cancer

$$PRG = \frac{TR * BW * ATc}{ET * EF * ED\left[\left(SA * Kp * ABS * CF * SF/ADJ\right) + \left(IR/SF\right)\right]}$$

Where:

PRG	=	Preliminary Remediation Goal	calculated in mg/L
THQ	=	Target Hazard Quotient	1 — unitless
TR	=	Target Risk	1^{-6}
BW_{adol}	=	Body Weight — Adolescent[a,c]	46 kg
BW_{adult}	=	Body Weight — Adult	70 kg
$ATnc_{-adol}$	=	Averaging Time Noncancer — Adolescent	3,650 days
$ATnc_{-adult}$	=	Averaging Time Noncancer — Adult	9,125 days
AT_c	=	Averaging Time Cancer	25,550 days
ET	=	Exposure Time[a]	1 hours
EF	=	Exposure Frequency[b]	45 days/yr
$ED_{adol.}$	=	Exposure Duration — Adolescent[c]	10 yrs
ED_{adult}	=	Exposure Duration — Adult	25 yrs
SA_{adol}	=	Skin Surface Area — Adolescent[a]	1.56 m^2/hr
SA_{adult}	=	Skin Surface Area — Adult[a]	2.3 m^2/hr
IR	=	Ingestion Rate[f]	0.05 L/hr
Kp	=	Dermal Permeability Constant[d]	chemical specific (cm/hr)
ABS	=	Absorption Factor[b]	chemical specific (unitless)
ADJ	=	Dermal Adjustment[b]	chemical specific (unitless)
RfD	=	Reference Dose	chemical specific (mg/kg-day)
SF	=	Slope Factor	([mg/kg-day]$^{-1}$)
CF	=	Conversion Factor	10 L/cm-m^2

Notes:

a = *Wildlife Exposure Factors Handbook*, (USEPA 1997) EPA/600/P-95/002Fa. Office of Research and Development, National Center for Environmental Assessment, Washington, DC.

b = *Supplemental Guidance to RAGS: Region 4 Bulletins, Human Health Risk Assessment* (Interim Guidance) (USEPA 1995). Waste Management Division, Office of Health Assessment.

c = The adolescent is assumed to be between the ages of 7 and 17 years of age.

d = Oak Ridge National Laboratory (ORNL). *Risk Assessment Information System*. Available online at http://risk.lsd.ornl.gov.

Surface Water

Limited surface water sampling for ecological risk indicated one VOC, no detectable SVOCs, two pesticides, no detectable PCBs and 14 metals in the brackish water of Bayou Grande. Table 7-13 summarizes surface water data and compares them with AWQCs, Florida Surface Water Quality Criteria (SWQC), and surface water PRGs. The surface water PRGs in Table 7-13 represent the lowest value calculated for either the adolescent recreational swimmer or the adult commercial worker. Comparisons in this risk assessment were primarily with federal and surface water PRGs, since these concentrations are both risk-based. The Florida SWQCs are a mixture of human health risk-based and ecological health-based concentrations, and are presented for informational purposes only, not as risk assessment screening tool. As shown, only one surface water concentration of arsenic from AZ-1 was reported at levels above the federal AWQC. Arsenic was not identified as a chemical of concern (COC) based on evaluation of the fish tissue data as presented in the following subsection.

Fishing and Crabbing

Fishing and crabbing are allowed and observed in the Bayou Grande, although access is limited to boating traffic because of base restrictions on the southern side of the bayou and private residences on the north and west sides. In addition, Homeland Security Restrictions, instituted after September 11, 2001, prohibit boat traffic in the area designated as Site 40.

Bayou Grande does not support sufficient game for subsistence fishing, based on the habitat and biota survey data in the ERA and information received from the Florida Marine Patrol Office pertaining to the frequency of fishing in Bayou Grande. Between April and September, approximately 10 boats per day fish in the bayou, and between October and March, only one or two boats per day are observed. A full bag limit (one redfish and five trout) is not frequently observed and most boats catch only one redfish or trout.

Table 7-13
Surface Water Data Summary and Screening Comparisons
NAS Pensacola, Site 40, Bayou Grande — Pensacola, Florida

	Frequency of Detection		Range of Detected Concentrations		Range of SQL		Risk-Based PRG[a]	Federal Ambient Water Quality Criteria[b]	Florida Class III Water Quality Criteria (Marine)[c]	Units
Aluminum	3	3	73.8	194	NA	NA	7500000	NA	1500	µg/L
Arsenic	1	3	2.5	2.5	2.2	2.2	21	0.14	50	µg/L
Barium	3	3	17.1	18	NA	NA	520000	NA	NA	µg/L
Calcium	3	3	183000	191000	NA	NA	NA	NA	NA	µg/L
Chromium	1	3	1.4	1.4	0.88	0.88	37000	NA	11	µg/L
Copper	3	3	2.1	7.8	NA	NA	300000	NA	2.9	µg/L
Delta-BHC	1	3	0.0031	0.0031	0.0052	0.05	17	NA	NA	µg/L
Endrin	1	3	0.0071	0.0071	0.1	0.1	2200	0.81	0.0023	µg/L
Iron	3	3	34.7	230	NA	NA	NA	NA	300	µg/L
Magnesium	3	3	599000	615000	NA	NA	NA	NA	NA	µg/L
Manganese	1	3	7.9	7.9	0.3	0.3	150000	NA	NA	µg/L
Potassium	3	3	25500	278000	NA	NA	NA	NA	NA	µg/L
Selenium	1	3	3.6	3.6	2.6	2.6	37000	NA	71	µg/L
Sodium	3	3	5180000	5420000	NA	NA	NA	NA	NA	µg/L
Toluene	1	3	0.33	0.33	1	1	1300000	200000	NA	µg/L
Vanadium	2	3	2.1	2.1	2.1	2.1	52000	NA	NA	µg/L
Zinc	1	3	17.9	17.9	3.7	3.7	2200000	NA	86	µg/L

Notes:
[a] = Risk-based surface water PRG which considers recreational and commercial uses of surface water.
[b] = Risk-based Federal Ambient Water Quality Criteria which considers the consumption of organisms only. (see 40 CFR 131.36)
[c] = Florida Criteria for Surface Water Quality Classifications, Class III — Marine. (see F.A.C. 62-302.530)

Commercial fishing does not occur in Pensacola Bay or any other Florida coastal water due to the State's limit on marine net fishing; therefore, fishing in Bayou Grande is limited to a recreational activity pattern in the areas outside the Homeland Security Restriction area. Despite the evidence that subsistence fishing does not occur in the bayou, this pathway was included in the risk assessment for comparison. Consequently, ingestion of contaminated fish tissue was evaluated for recreational as well as subsistence fishing.

Table 7-14, compares maximum detected values in fish tissue collected from Site 40 to fish ingestion risk-based concentrations (RBCs) (USEPA, April 2, 2002). This analytical data is provided in Appendix C of the Final Site 40 RI Report (January 20, 1999). Risk estimates were calculated using the ratio of the fish ingestion RBC and reported concentration. The fish ingestion RBCs are based on a daily consumption rate of 54 grams per day (g/day) for the entire year (350 days per year). This ingestion rate and exposure frequency are equivalent to the per capita intake value of 59 g/day reported in the USEPA *Wildlife Exposure Factors Handbook* for the Native American Subsistence Fishing Population (Table 6-85, p. 10-80).

Table 7-14
Comparison of Maximum Detections in Whole Body Prey Fish to RBCs

		Fish RBCs (mg/kg)[1]		
Constituents	**Max. Detected Concentrations[2] (mg/kg)**	**Carcinogens**	**Non-carcinogens**	**Exceeds RBC?**
4,4'-DDD	3.8E-3[3]	1.3E-2	6.8E-1	No
4,4'-DDE	1.2E-2[3]	9.3E-3	6.8E-1	Yes
Aldrin	6.6E-4	1.9E-4	4.1E-2	Yes
Aroclor-1260	1.0E-1[4]	1.6E-3	2.7E-2	Yes
Dieldrin	1.3E-3	2.0E-4	6.8E-2	Yes
Lindane	7.4E-4	2.4E-3	4.1E-1	No
Chlordane	1.7E-3	9.0E-3	6.8E-1	No
Mercury	6.0E-2	NA	4.1E-1	No

Notes:
RBC = Risk-based concentration.
1 = Fish RBC values represent risk-based concentrations calculated for subsistence fishermen.
2 = Maximum detected concentrations from Phase IIB/III prey fish tissue samples except for mercury. Since mercury not analyzed for in Phase IIB/III, the maximum detected prey fish mercury concentration from 2001 samples was used.
3 = Reference dose for DDT used to calculate non-carcinogenic RBC.
4 = Reference dose for Aroclor-1254 used to calculate non-carcinogenic RBC.

The tissue data in Table 7-14 are not from game fish typically harvested by humans. Rather, these data represent whole-body prey species (i.e., pinfish and killifish). Organic concentrations in game fish were estimated based on whole body tissue concentrations reported in the prey species using TTCs (USEPA, Draft Water Quality Criteria Methodology Revisions: Human Health, Federal Register, August 14, 1998). Mercury concentrations were calculated using the red drum mercury model as presented in the Final RI Addendum 2 (EnSafe Inc. [EnSafe], August 9, 2002).

Table 7-15 outlines the assumptions used in making the risk calculations. The table lists the adjustment factors used to determine the risks at Site 40.

Table 7-15
Risk Assessment Assumptions
Assumptions

Adjustment Factor[1]		RME	Most Conservative	Rationale
SFF	Adjustment	0.32 2 0.64	1 NA 1	Fish forage equally throughout Bayou Grande; Site 40 is one-third of Bayou Grande Site 40 may contain better forage.
Fraction Contaminated Area/Site 40 Area	Adjustment	GIS estimate 2 2 x est.	NA NA NA	Geographic sediment distribution ~ fish tissue distribution**.** Fish are more widespread than sediment**.**
Fraction Annual Use by Fishermen		1	NA	Fishing occurs year-round.
Fraction Annual Use by Fish		1	NA	Fish do not migrate.
Fraction Successful Fishing in Bayou Grande		0.5	1	Based on Florida Marine Patrol Office; remainder of bag limit assumed to be caught elsewhere; one-half of the 0.26 kg/day fish tissue would be obtained elsewhere**.**
Fraction Fishing at Site 40	Adjustment	0.15 2 0.3	0.3 2 0.6	Forested banks would be more attractive to fishermen. However, Homeland Security restrictions prohibit boat traffic within 300 feet of the shore.

Notes:
RME = Reasonable maximum exposure.
SFF = Site foraging factor.
1 = Adjustment was made to account for uncertainty.

Table 7-16 presents the estimated concentration in game fish using the fractional assumptions presented in Table 7-15. The formulas utilized in determining the estimated concentrations are presented in Addendum 1 (EnSafe, August 26, 2003).

Table 7-16
Estimated Concentrations in Game Fish Species

Constituents	Measured Conc. in Prey Fish (mg/kg)	TTC	Estimated Conc. in Game Fish (mg/kg) SFF = 1	SFF = 0.64
4,4'-DDD	3.8E-3	3.254	1.2E-2	7.9E-3
4,4'-DDE	1.2E-2	3.602	4.3E-2	2.8E-2
Aldrin	6.6E-4	1.006	6.6E-4	4.2E-4
Aroclor-1260	1.0E-1	3.733	3.7E-1	2.4E-1
Dieldrin	1.3E-3	1.063	1.4E-3	8.8E-4
Lindane	7.4E-4	1.021	7.6E-4	4.8E-4
Chlordane	1.7E-3	1.999	3.4E-3	2.2E-3
Mercury[1]	6.0E-2	NA	2.6E-01	1.7E-1

Notes:
TTC = Trophic transfer coefficient from USEPA, *Draft Water Quality Criteria Methodology. Revisions: Human Health*, Federal Register, August 14, 1998.
SFF = Site foraging factor.
1 = Mercury concentrations in upper trophic level fish tissue refer to methylmercury and were modeled as described in Addendum 2.

The final Site 40 RFI Report (EnSafe, January 20, 1999) did not contain figures for aldrin or chlordane because of the lack of a SSV for aldrin and because detected concentrations of chlordane did not exceed its SSV. Given this fact, contoured estimations of the fraction of aldrin and chlordane contaminated areas within the total Site 40 area were calculated for the HHRA.

The risk to the receptor populations was estimated by using the following equations:

Carcinogenic Effects:

Risk = CDI*Slope Factor

Non-carcinogenic Effects:

HQ = CDI/RfD

Where:

Risk = probability of a carcinogenic health impact exposure to constituents of potential concern (COPC)

HQ = hazard quotient, referring to the ratio of exceedance of a non-carcinogenic health impact

CDI	=	receptor and route-specific chronic daily intake (mg/kg-day)
Slope Factor	=	toxicity value that relates dose to response (kg-day/mg)
RfD	=	reference doses for no significant health impacts (mg/kg-day)

The slope factor and the RfD must be appropriate for the specific receptor and route and are determined for an administered dose for this risk assessment (based on fish ingestion).

The following tables summarize the risk characterization results for the fishermen receptor population. Tables 7-17 and 7-18 summarize the carcinogenic risk characterization results, while Tables 7-19 and 7-20 summarize the non-carcinogenic risk characterization results for recreational fisherman. Tables 7-21 through 7-24 summarize the carcinogenic risk and non-carcinogenic risk characterization results for the unlikely subsistence fisherman.

Based on these tables, the primary risk driver for fish tissue consumption would be Aroclor-1260 (a PCB), because these concentrations result in approximately one order of magnitude more risk than the other contributors. The remaining chemicals listed in these tables could contribute to excess human health risk. The Aroclor-1260 RBC for fish tissue ingestion is 0.0016 mg/kg (USEPA Region 3, 1998), based on a slope factor of 2.0 kg-d/mg and target risk of 10E-6.

7.2.2 Human Health Risk Assessment Uncertainties

General uncertainties are inherent in human health risk assessments. Table 7-25 lists the types of uncertainties that could impact final risk calculations. A plus (+) or minus (-) is associated with each uncertainty to provide a quantitative perspective.

Table 7-17
Site 40 Summary of Risk Characterization Results: Carcinogenic Effects;
Recreational Fishing Scenario (SFF 0.64, Fca from Table 4, Fusf 0.3)

	CDI (mg/kg-day) Recreational Fishermen			Carcinogenic Risk Recreational Fishermen	
Constituents	**Based on LWA Health Advisory Fish Intake Rate**	**Based on Adult Fish Intake Rate**	**Oral Slope Factor (mg/kg-day)**	**Based on LWA Health Advisory Fish Intake Rate**	**Based on Adult Fish Intake Rate**
4,4'-DDD	5.1E-9	1.5E-8	2.4E-1	1.2E-9	3.6E-9
4,4'-DDE	3.3E-8	9.6E-8	3.4E-1	1.1E-8	3.3E-8
Aldrin	7.0E-12	2.1E-11	1.7E+1	1.2E-10	3.5E-10
Aroclor-1260	5.5E-7	1.6E-6	2.0E+0	1.1E-6	3.2E-6
Dieldrin	6.9E-9	2.0E-8	1.6E+1	1.1E-7	3.2E-7
Lindane	3.3E-9	9.6E-9	1.3E+0	4.3E-9	1.3E-8
Chlordane	6.0E-9	1.7E-8	3.5E-1	2.1E-9	6.1E-9
Mercury[1]	NA	NA	NA	NA	NA
			Total =	**1.23E-6**	**3.6E-6**

Notes:
CDI = Chronic Daily Intake.
LWA = Lifetime weighted average.
mg/kg/day = Milligrams per kilogram per day.
SFF = Site foraging factor = 0.64.
Fca = Fraction of contaminated area; see Table 4.
Fusf = Fraction of use and successful fishing = 0.3.
1 = Mercury form reported is methylmercury; cancer risk not applicable because methyl mercury is not a carcinogen.

Table 7-18
Summary of Risk Characterization Results: Carcinogenic Effects;
Recreational Fishing Scenario (SFF 1.0, Fca 1.0, Fusf 0.6)

	CDI (mg/kg-day) Recreational Fishermen			Carcinogenic Risk Recreational Fishermen	
Constituents	**Based on LWA Health Advisory Fish Intake Rate**	**Based on Adult Fish Intake Rate**	**Oral Slope Factor (mg/kg-day)**	**Based on LWA Health Advisory Fish Intake Rate**	**Based on Adult Fish Intake Rate**
4,4'-DDD	3.9E-7	1.1E-6	2.4E-1	9.3E-8	2.7E-7
4,4'-DDE	1.4E-6	4.0E-6	3.4E-1	4.6E-7	1.3E-6
Aldrin	2.1E-8	6.1E-8	1.7E+1	3.5E-7	1.0E-6
Aroclor-1260	1.2E-5	3.4E-5	2.0E+0	2.3E-5	6.8E-5
Dieldrin	4.3E-8	1.3E-7	1.6E+1	6.9E-7	2.0E-6
Lindane	2.4E-8	6.9E-8	1.3E+0	3.1E-8	9.0E-8
Chlordane	1.1E-7	3.1E-7	3.5E-1	3.7E-8	1.1E-7
Mercury[1]	NA	NA	NA	NA	NA
			Total =	**2.5E-5**	**7.33E-5**

Notes:
CDI = Chronic Daily Intake.
LWA = Lifetime weighted average.
mg/kg/day = Milligrams per kilogram per day.
SFF = Site foraging factor = 1.0.
Fca = Fraction of contaminated area = 1.0.
Fusf = Fraction of use and successful fishing = 0.6.
1 = Mercury form reported is methylmercury; cancer risk not applicable because methyl mercury is not a carcinogen.

Table 7-19
Summary of Risk Characterization Results: Non-carcinogenic Effects;
Recreational Fishing Scenario (SFF 0.64, Fca from Table 4, Fusf 0.3)

Constituents	CDI (mg/kg-day) Recreational Fishermen Based on Adult Fish Intake Rate	Oral RfD (mg/kg-day)	Non-carcinogenic Risk Recreational Fishermen Based on Adult Fish Intake Rate
4,4'-DDD	3.5E-8	5.00000000000e-42	0
4,4'-DDE	2.3E-7	5.00000000000e-42	0
Aldrin	4.8E-11	3.0E-5	0
Aroclor-1260	3.8E-6	2.00000000000e-53	0
Dieldrin	4.7E-8	5.0E-5	0
Lindane	2.2E-8	3.0E-4	0
Chlordane	4.1E-8	5.0E-4	0
Mercury	7.6E-6	0.0003	0
		Total =	**0**

Notes:

SFF	=	Site foraging factor = 0.64.
Fca	=	Fraction of contaminated area; see Table 4.
Fusf	=	Fraction of use and successful fishing = 0.3.
CDI	=	Chronic daily intake.
1	=	Reported oral RfD value is for elemental mercury.
2	=	Reference dose for DDT used to calculate non carcinogenic RBC.
3	=	Reference dose for Aroclor-1254 used to calculate non carcinogenic RBC.

Table 7-20
Summary of Risk Characterization Results: Non-carcinogenic Effects;
Recreational Fishing Scenario (SFF 1.0, Fca 1.0, Fusf 0.6)

Constituents	CDI (mg/kg-day) Recreational Fishermen Based on Adult Fish Intake Rate	Oral RfD (mg/kg-day)	Non-carcinogenic Risk Recreational Fishermen Based on Adult Fish Intake Rate
4,4'-DDD	2.6E-6	5.00000000000e-42	0
4,4'-DDE	9.2E-6	5.00000000000e-42	0
Aldrin	0	3.0E-5	4.3E-12
Aroclor-1260	8.0E-5	2.00000000000e-53	0
Dieldrin	3.0E-7	5.0E-5	1.5E-11
Lindane	1.6E-7	3.0E-4	4.8E-11
Chlordane	7.3E-7	5.0E-4	3.6E-10
Mercury	5.5E-5	0.0003	0
		Total =	**0**

Notes:

SFF	=	Site foraging factor.
Fca	=	Fraction of contaminated area; see Table 4.
Fusf	=	Fraction of use and successful fishing.
CDI	=	Chronic daily intake.
1	=	Reported oral RfD value is for elemental mercury

Table 7-21
Site 40 Calculation of Chronic Daily Intakes of Constituents in Fish Tissue: Carcinogenic Effects; Subsistence Fishing Scenario (SFF 1.0, Fca 1.0, Fusf 0.6)

Constituents	Concentration in Upper Trophic Level Fish (mg/kg)	Ing. Rate Adult Subsistence Fisherman	Fusf	Fca	CDI for Carcinogenic
4,4'-DDD	1.2E-2	1.7E-1	6.0E-1	1.0E+00	7.4E-6
4,4'-DDE	4.3E-2	1.7E-1	6.0E-1	1.0E+00	2.6E-5
Aldrin	6.6E-4	1.7E-1	6.0E-1	1.0E+00	4.0E-7
Aroclor-1260	3.7E-1	1.7E-1	6.0E-1	1.0E+00	2.2E-4
Dieldrin	1.4E-3	1.7E-1	6.0E-1	1.0E+00	8.3E-7
Lindane	7.6E-4	1.7E-1	6.0E-1	1.0E+00	4.5E-7
Chlordane	3.4E-3	1.7E-1	6.0E-1	1.0E+00	2.0E-6
Mercury[1]	2.6E-1	1.7E-1	6.0E-1	1.0E+00	NA

Notes:
Subsistence fisherman fish tissue intake rate is 0.170 kg/day (USEPA, 1997).
CDI = Chronic Daily Intake.
Fca = Fraction of contaminated area =1.0.
Fusf = Fraction of successful fishing = 0.6.
SFF = Site foraging factor = 1.0.
mg/kg/day = Milligrams per kilogram per day.
1 = Mercury form reported is methylmercury; cancer risk not applicable because methyl mercury is not a carcinogen.

Table 7-22
Summary of Risk Characterization Results: Carcinogenic Effects; Subsistence Fishing Scenario (SFF 1.0, Fca 1.0, Fusf 0.6)

Constituents	CDI (mg/kg-day) Subsistence Fishermen	Oral Slope Factor (mg/kg-day)		Carcinogenic Risk Subsistence Fishermen
4,4'-DDD	7.4E-6	2.4E-1		1.8E-6
4,4'-DDE	2.6E-5	3.4E-1		8.8E-6
Aldrin	4.0E-7	1.7E+1		6.8E-6
Aroclor-1260	2.2E-4	2.0E+0		4.5E-4
Dieldrin	8.3E-7	1.6E+1		1.3E-5
Lindane	4.5E-7	1.3E+0		5.9E-7
Chlordane	2.0E-6	3.5E-1		7.1E-7
Mercury[1]	NA	NA		NA
			Total =	**4.79E-4**

Notes:
CDI = Chronic Daily Intake.
SFF = Site foraging factor = 1.0.
Fca = Fraction of contaminated area = 1.0
Fusf = Fraction of successful fishing = 0.6.
mg/kg/day = Milligrams per kilogram per day.
1 = Mercury form reported is methylmercury; cancer risk not applicable because methyl mercury is not a carcinogen.

Table 7-23
Calculation of Chronic Daily Intakes of Constituents in Fish Tissue:
Non-carcinogenic Effects; Subsistence Fishing Scenario (SFF 1.0, Fca 1.0, Fusf 0.6)

Constituents	Concentration in Upper Trophic Level Fish (mg/kg)	Ing. Rate Adult Subsistence Fisherman	Fusf	Fca	CDI for Non-carcinogenic Effects (mg/kg-day) Subsistence Fishermen
4,4'-DDD	1.2E-2	1.7E-1	6.0E-1	1.0E+0	1.7E-5
4,4'-DDE	4.3E-2	1.7E-1	6.0E-1	1.0E+0	6.0E-5
Aldrin	6.6E-4	1.7E-1	6.0E-1	1.0E+0	9.3E-7
Aroclor-1260	3.7E-1	1.7E-1	6.0E-1	1.0E+0	5.2E-4
Dieldrin	1.4E-3	1.7E-1	6.0E-1	1.0E+0	1.9E-6
Lindane	7.6E-4	1.7E-1	6.0E-1	1.0E+0	1.1E-6
Chlordane	3.4E-3	1.7E-1	6.0E-1	1.0E+0	4.7E-6
Mercury[1]	2.6E-1	1.7E-1	6.0E-1	1.0E+0	3.6E-4

Notes:
Subsistence fisherman fish tissue intake rate is 0.17 kg/day (USEPA,1997).
SFF = Site Foraging Factor = 1.0.
Fca = Fraction of contaminated area = 1.0.
Fusf = Fraction of use and successful fishing = 0.6.
CDI = Chronic daily intake
1 = Mercury form reported is methylmercury; cancer risk not applicable because methyl mercury is not a carcinogen.

Table 7-24
Summary of Risk Characterization Results: Non-carcinogenic Effects;
Subsistence Fishing Scenario (SFF 1.0, Fca 1.0, Fusf 0.6)

Constituents	CDI (mg/kg-day) Subsistence Fishermen Based on Adult Fish Intake Rate	Oral RfD (mg/kg-day)	Non-carcinogenic Risk Subsistence Fishermen Based on Adult Fish Intake Rate
4,4'-DDD	0.000017	5.00000000000e-42	0
4,4'-DDE	0.00006	5.00000000000e-42	0
Aldrin	0	3.0E-5	
Aroclor-1260	0.00052	2.00000000000e-53	0
Dieldrin	0.000002	5.0E-5	9.7E-11
Lindane	0.000001	3.0E-4	3.2E-10
Chlordane	0.000005	5.0E-4	2.4E-9
Mercury	0.00036	0.0003	0
		Total =	**0**

Notes:
SFF = Site foraging factor = 1.0.
Fca = Fraction of contaminated area = 1.0.
Fusf = Fraction of use and successful fishing = 0.6.
CDI = Chronic daily intake.
1 = Reported oral RfD value is for elemental mercury.
2 = Reference dose for DDT used to calculate non carcinogenic RBC.
3 = Reference dose for Aroclor-1254 used to calculate non carcinogenic RBC.

Table 7-25
Uncertainties Associated with the Human Health Risk Assessment at Site 40, Bayou Grande

Uncertainty Issue	Effect on HHRA
PCBs are a common contaminant that are endemic to coastal areas	+
The maximum detected concentration in the in prey fish from Site 40 was used as a health-protective surrogate for the mean for this risk assessment — it is very unlikely that all fish preyed on would be contaminated at the maximum detected level	+
Life history considerations for the red drum show the home range to be larger — the fish feed in a larger area which may be more or less contaminated, which may under or overestimate risk	+ or -
Many gamefish feed on other food sources besides fish	+
It was assumed that all of the contaminant was ingested regardless of the way the fish was cooked or eaten — it is likely that the estimated risks to the receptor populations were overestimated	+
The risk calculated for Site 40 is below what the Food and Drug Administration considers allowable for human food	+
Subsistence fishing is not believed to occur in Bayou Grande — the use of the Region 3 RBC values may overestimate risk	+
Use of a trophic transfer coefficient to estimate the tissue concentration in upper trophic level species based on concentrations detected in lower trophic organisms	+
Surface water samples collected during Phase IIA were biased to areas of Phase IIA high sediment concentrations, and risk may be under or overestimated	+ or -
Whole-body tissue data from prey species and calculated tissue data from predatory fish suggest a risk to humans greater than Florida's acceptable risk level of 10E-6, mainly from organochlorine pesticide and Aroclor-1260 concentrations, but it is very unlikely that all fish preyed on by upper trophic level fish (game fish) would be contaminated at the maximum detected level	+
Concentrations in upper trophic fish are based on a model and may differ from actual concentrations in game fish	+

7.3 Human Health Risk Summary

Surface Water

Surface water data were summarized and screened against risk-based surface water PRGs and AWQCs. No other chemical except arsenic exceeded either screening value. Arsenic was reported in surface water at a concentration above its AWQC, but was not subsequently identified as a COC based on the risk-based evaluation of fish tissue data.

Fish Consumption

Whole-body tissue data from prey species and calculated tissue data from predatory fish (game fish/upper predatory fish) suggest a risk to humans greater than Florida's acceptable risk level of 10^{-6}, mainly from organochlorine pesticides and Aroclor-1260 concentrations. Concentrations in upper trophic-level fish are based on a model and may differ from actual

concentrations in game fish. 4,4'-DDT has been banned from the U.S. since 1972 and PCBs were banned in 1977. 4,4'-DDT is breaking down to its daughter products 4,4'-DDE and 4,4'-DDD, as demonstrated by the higher concentrations of these compounds 4,4'-DDE and 4,4'-DDD in sediment and prey fish. 4,4'-DDT was not detected in the prey fish samples. With one exception, all concentrations of 4,4'-DDT and its metabolites detected in sediment were below their respective background concentrations. As stated previously, concentrations in upper trophic fish are based on a model and may differ from actual concentrations in game fish. The model demonstrates the upper boundary of COPCs based on whole body consumption, not edible tissue only. Further, 4,4'-DDT and its metabolites and PCBs have not been identified as potential ecological parameters of concern for any of the terrestrial IRP sites potentially impacting Bayou Grande.

8.0 DOCUMENTATION OF SIGNIFICANT CHANGES FROM PROPOSED PLAN

The proposed plan for OU 15 released on May 23, 2004, identified the no-action alternative as the preferred alternative. The no-action alternative presented in the proposed plan is the same as the no-action alternative described in this ROD. Both comments received during the public comment period supported the no-action alternative.

9.0 RESPONSIVENESS SUMMARY

Overview

At the time of the public comment period, the U.S. Navy had selected a preferred remedy to address sediment and surface water at NAS Pensacola Site 40. This preferred remedy was selected in coordination with the USEPA and the FDEP. The NAS Pensacola Restoration Advisory Board, a group of community volunteers, reviewed the technical details of the selected remedy and raised no fundamental objections to its selection.

The sections below describe the background of community involvement in the project and comments received during the public comment period.

Background of Community Involvement

Throughout the site's history, the community has been kept abreast of site activities through press releases to the local newspaper and television stations. Site-related documents were made available to the public in the Administrative Record stored at information repositories maintained at the NAS Pensacola Library and the John C. Pace Library of the University of West Florida.

Advertisements were placed in the *Pensacola News Journal* to announce the public comment period May 23, 2004, through July 6, 2004, present the opportunity for a public meeting, and briefly summarize the proposed plan. In conjunction with these newspaper announcements, the proposed plan was sent to all addresses on the Site 40 mailing list.

Summary of Comments Received During the Public Comment Period

Two comments were received during the public comment period. Both comments supported the preferred alternative of no-action.

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Appendix A
Glossary

This glossary defines terms used in this ROD to describe CERCLA activities. The definitions apply specifically to this ROD and may have other meanings when used in different circumstances.

ADMINISTRATIVE RECORD: A file that contains all information used by the lead agency to make its decision in selecting a response action under CERCLA. This file is to be available for public review and a copy is to be established at or near the site, usually at one of the information repositories. A duplicate is also filed in a central location, such as a regional or state office.

AQUIFER: An underground formation of materials such as sand, soil, or gravel that can store and supply groundwater to wells and springs. Most aquifers used in the United States are within a 1,000 feet of the earth's surface.

BASELINE RISK ASSESSMENT: A study conducted to supplement a remedial investigation to determine the nature and extent of contamination at a Superfund site and the risks posed to public health and/or the environment.

CARCINOGEN: A substance that can cause cancer.

CLEANUP: Actions taken to deal with a release or threatened release of hazardous substances that could affect public health and/or the environment. The noun "cleanup" is often used broadly to describe various response actions or phases of remedial responses such as Remedial Investigation/Feasibility Study.

COMMENT PERIOD: A time during which the public can review and comment on various documents and actions taken, either by the Department of Defense installation or the USEPA. For example, a comment period is provided when USEPA proposes to add sites to the National Priorities List.

COMMUNITY RELATIONS: USEPA's, and subsequently Naval Air Station Pensacola's, program to inform and involve the public in the Superfund process and respond to community concerns.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA): A federal law passed in 1980 and modified in 1986 by the Superfund Amendments and Reauthorization Act (SARA). The act created a special tax that goes into a trust fund, commonly known as "Superfund," to investigate and clean up abandoned or uncontrolled hazardous waste sites.

Under this program the USEPA can either:

- Pay for site cleanup when parties responsible for the contamination cannot be located or are unwilling or unable to perform the work.

- Take legal action to force parties responsible for site contamination to clean up the site or repay the federal government for the cost of cleanup.

DEFENSE ENVIRONMENTAL RESTORATION ACCOUNT (DERA): An account established by Congress to fund DOD hazardous waste site cleanups, building demolition, and hazardous waste minimization. The account was established under SARA.

DRINKING WATER STANDARDS: Standards for quality of drinking water that are set by both the USEPA and the FDEP.

EXPLANATION OF DIFFERENCES: After adoption of the final remedial action plan, if any remedial or enforcement action is taken, or if any settlement or consent decree is entered into, and if the settlement or decree differs significantly from the final plan, the lead agency is required to publish an explanation of any significant differences with rational.

FEASIBILITY STUDY: See Remedial Investigation/Feasibility Study.

GROUNDWATER: Water beneath the earth's surface that fills pores between materials such as sand, soil, or gravel. In aquifers, groundwater occurs in quantities sufficient for drinking, irrigation, and other purposes.

HAZARD RANKING SYSTEM (HRS): A scoring system used to evaluate potential relative risks to public health and the environment from releases or threatened releases of hazardous substances. USEPA and states use the HRS to calculate a site score, from 0 to 100, based on the actual or potential release of hazardous substances through air, surface water, or groundwater. This score is the primary factor used to decide if a hazardous site should be placed on the NPL.

HAZARDOUS SUBSTANCES: Any material that poses a threat to public health and/or the environment, typically those that are toxic, corrosive, ignitable, explosive, or chemically reactive.

INFORMATION REPOSITORY: A file containing information, technical reports, and reference documents regarding a Superfund site. Information repositories for Naval Air Station Pensacola are at the John C. Pace Library, University of West Florida; and the NAS Pensacola Library, Building 633, Naval Air Station, Pensacola, Florida.

MAXIMUM CONTAMINANT LEVEL: National standards for acceptable concentrations of contaminants in drinking water. These standards are legally enforceable standards set by the USEPA under the Safe Drinking Water Act.

MONITORING WELLS: Wells drilled at specific locations on or off a hazardous waste site where groundwater can be sampled at selected depths and studied to assess the groundwater flow direction, the types and amounts of contaminants present etc.

NATIONAL PRIORITIES LIST (NPL): The USEPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial response using money from the trust fund. The list is based primarily a site's Hazard Ranking System Score. USEPA is required to update the NPL at least once a year.

PARTS PER BILLION (ppb)/PARTS PER MILLION (ppm): Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene in a million ounces of water is 1 ppm; 1 ounce of trichloroethylene in a billion ounces of water is 1 ppb. If one drop

of trichloroethylene is mixed in a competition-size swimming pool, the water will contain about 1 ppb of trichloroethylene.

PRELIMINARY REMEDIATION GOALS: Screening concentrations provided by the USEPA and the FDEP used to assess the site for comparison before remedial goals are set during the Baseline Risk Assessment.

PROPOSED PLAN: A public participation requirement of SARA in which the lead agency summarizes for the public the preferred cleanup strategy and rationale for the preference, reviews the alternatives presented in the detailed analysis of the remedial investigation/feasibility study, and presents any waivers to cleanup standards of Section 121(d)(4) that may be proposed. This may be prepared either as a fact sheet or as a separate document. In either case, it must actively solicit public review and comment on all alternatives under agency consideration.

RECORD OF DECISION (ROD): A public document that explains which cleanup alternative(s) will be used at NPL sites. The Record of Decision is based on information and technical analysis generated during the remedial investigation/feasibility study and consideration of public comments and community concerns.

REMEDIAL ACTION (RA): The actual construction or implementation phase that follows the remedial design and selected cleanup alternative at an NPL site.

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS): Investigation and analytical studies usually performed at the same time, and together referred to as the "RI/FS." They are intended to (1) gather the data necessary to determine the type and extent of contamination at a Superfund site; (2) establish criteria for cleaning up the site; (3) identify and screen cleanup alternatives for remedial action; and (4) analyze the technology and costs of the alternatives in detail.

REMEDIAL RESPONSE: A long-term action that stops or substantially reduces a release or threatened release of hazardous substances that is serious, but does not pose an immediate threat to public health and/or the environment.

REMOVAL ACTION: An immediate action performed to address a release or threatened release of hazardous substances.

RESOURCE CONSERVATION AND RECOVERY ACT (RCRA): A federal law that established a regulatory system to track hazardous substances from the time of generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous substances. RCRA is designed to prevent new, uncontrolled hazardous waste sites.

RESPONSE ACTION: As defined by Section 101(25) of CERCLA, a response action means a removal, remedy, or remedial action, including related enforcement activities.

RESPONSIVENESS SUMMARY: A summary of oral and written public comments received by the lead agency during a comment period on key documents, and the response to these comments prepared by the lead agency. The responsiveness summary is a key part of the ROD, highlighting community concerns for USEPA decision-makers.

SECONDARY DRINKING WATER STANDARDS: Secondary drinking water regulations are set by the USEPA and the FDEP. These guidelines are not designed to protect public health; instead they are intended to protect "public welfare" by providing guidelines for the taste, odor, color, and other aesthetic aspects of drinking water that do no present a health risk.

SUPERFUND: A trust fund established by CERCLA which can be drawn on to plan and cleanup previous hazardous waste disposal sites, and current releases or threats of releases of non-petroleum products. Superfund is often divided into removal, remedial, and enforcement components.

SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA): The public law enacted on October 17, 1986, to reauthorize the funding provisions and amend the authorities and requirements of CERCLA and associated laws. Section 120 of SARA requires that all federal facilities "be subject to, and comply with, this act in the same manner and to the same extent as any non-governmental entity."

SURFACE WATER: Bodies of water that are above ground such as rivers, lakes, and streams.

VOLATILE ORGANIC COMPOUND: An organic (carbon-containing) compound that evaporates (volatilizes) readily at room temperature.

Appendix B
References

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